The AMSAT® Journal

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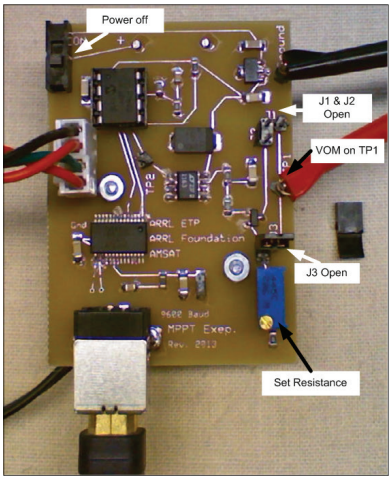
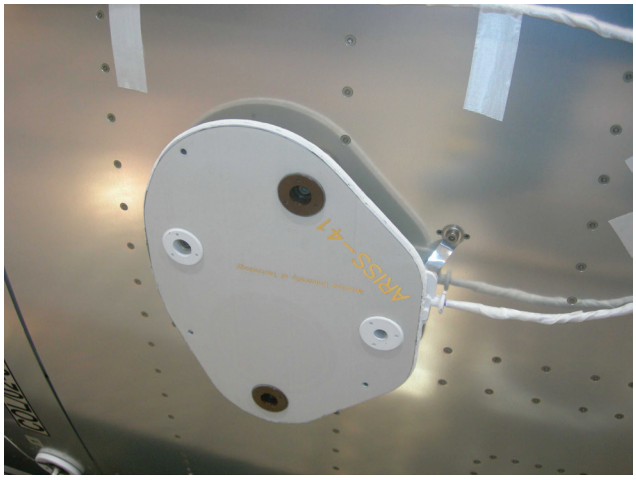


Classroom Education Opportunity with Fox-2 MPPT



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A codicil in your will, naming The Radio Amateur Satellite Corporation as a beneficiary will help insure the continuance of the Amateur Radio Satellite program.

Call the AMSAT-NA office at 301-589-6062 for questions on any or all of these ways you can help build new and exciting satellites.

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2013 AMSAT Board of Directors Election Results

AMSAT Manager Martha Saragovitz announced the results of the 2013 election of Board of Directors members.

As a result of the 2013 Board of Directors Election, Barry Baines, WD4ASW; Tony Monteiro, AA2TX, Alan Biddle, WA4SCA, and Mark Hammond, N8MH, will serve on the board for two years. The first alternate is JoAnne Maenpaa, K9JKM, and the second alternate is Steve Coy, K8UD. The results of the voting with 688 ballots cast is summarized in the table:

2013 Board of Directors Election Results	
Barry Baines, WD4ASW	521
Tony Monteiro, AA2TX	518
Alan Biddle, WA4SCA	424
Mark Hammond, N8MH	365
JoAnne Maenpaa, K9JKM	316
Steve Coy, K8UD	186
Frank Griffin, K4FEG	158
Bryan Klofas, KF6ZEO	141

AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.

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Second Alternate: **Steve Coy**, K8UD, k8ud@amsat.org

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Vice-President Human Spaceflight: Frank Bauer, KA3HDO
Vice President, Educational Relations: Mark Hammond, N8MH

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President Emeritus: Tom Clark, K3IO
Founding President: Perry Klein, W3PK

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Fall is now upon us with cooling temperatures and a return to the hectic schedules that many of us have. The same is true for our volunteers at AMSAT.

AMSAT Space Symposium

The Fall highlight for AMSAT is the 31st AMSAT Space Symposium that takes place 1-3 NOV 13 in Houston, TX. As this issue of The *AMSAT Journal* will be delivered to our membership prior to Symposium, I want to encourage you to participate in this year's event. Details may be found on the AMSAT website (www.amsat.org), but it worth noting some key highlights:

- The AMSAT Board of Directors Meeting takes place all day Thursday, 31 OCT 13 and Friday morning, 1 NOV. The meeting is open with the exception of a closed session for a portion of Friday morning.

- Presentation of papers that are published in the Proceedings of the 31st AMSAT Space Symposium and Annual Meeting takes place Friday afternoon and Saturday. Expect presentations on the Fox-1 class satellites, ground station operations from various venues, Amateur Radio on the International Space Station (ARISS), Using the Fox-class satellites in the Classroom, Ham TV on the ISS, and other topics.

- An informal AMSAT reception takes place Friday evening.

- The AMSAT Annual Meeting where the AMSAT leadership provides an overview of the "State of AMSAT" as well as addresses member questions takes place Saturday afternoon. We also take time to recognize the accomplishments of our volunteers over the past 12 months.

- Our banquet "speaker" is a multi-media panel session celebrating 30 years of amateur radio and human space flight. Owen Garriott, W5LFL's historic flight in November 1983 on board STS-9 was the first time that amateur radio was used by an astronaut to speak with amateurs on the ground. This also represented the first time that the general public could talk to U.S. astronauts from space, outside the communications channels of NASA's Mission Control. Owen is scheduled to attend the banquet and share his thoughts on his experiences of operating from the space shuttle. We also expect other key participants who will help tell the story of the past 30 years of amateur radio and human space flight. AMSAT VP-Human Space Flight, Frank Bauer, KA3HDO will serve as panel moderator. Details of what is planned may be found on the AMSAT website.

- Patrick Stoddard, WD9EWK is our new Director-Field Operations; he will lead our "Field Ops Breakfast" on Sunday morning where our Area Coordinators and others interested in serving as "ambassadors of AMSAT" in their communities share ideas and expectations for 2014.

- The IARU Satellite Advisor, Hans Van de Groenendaal, ZS6AKV will hold an "IARU Satellite Forum" on Sunday morning. Hans alternates between the AMSAT-UK Colloquium (even years) and the AMSAT Space Symposium (odd years) in providing an overview of IARU satellite frequency coordination matters.

- A tour of the USS Texas (BB-35) will take place on Sunday, 3 NOV; the only battleship that served in both world wars. The cost of the tour is $20.00. This will be a unique behind-the scenes look at the ship, including the radio room. A collection of private vehicles supplied by our host, the JSC Amateur Radio Club, will provide transportation with expected departure at 1030. You must sign up for the tour on the AMSAT website.

- A tour of Johnson Space Center is offered on Monday, 4 NOV. The bus leaves at 0800 from the hotel and will include stops at various key facilities, including the Sonny

continued on page 4 ...

Apogee View - continued from page 3 ...

Carter Neutral Buoyancy Lab and the Building 9 Training facility containing high fidelity full scale mockups of the International Space Station modules as well as the Soyuz spacecraft. The ISS tour will include special emphasis of the amateur radio stations on the ISS. The tour will also include the Building 30 historic mission control room as well as the current International Space Station control room. We also expect to see the JSC amateur radio club station, W5RRR. Cost of the tour is $30.00 to cover bus transportation. Contact Martha at the AMSAT office to reserve your seat and provide her with the information needed to give NASA in advance of our time on the facility.

The Symposium is a unique opportunity to meet with key personnel of AMSAT, interact with fellow satellite operators, and learn the latest of what is happening with our engineering programs and the organization. I hope to see you there!

AMSAT Board of Directors Election

Results of the 2013 BoD election were announced on 15 SEP 13. Congratulations to those who were elected:

- Barry Baines, WD4ASW
- Alan Biddle, WA4SCA
- Mark Hammond, N8MH
- Anthony Montiero, AA2TX

Mark is our latest board member, having served as an alternate in 2012 and 2013. He replaces Andrew Glasbrenner, KO4MA who served on the BoD from 2007-2013 and decided not to run again. Thank you, Drew for your dedication and service to AMSAT. We are fortunate that Drew has agreed to continue to serve AMSAT as VP-Operations.

We also thank Patrick Stoddard, WD9EWK who served as second alternate in 2013 and decided not to run for the BoD in this year's election. Patrick continues to serve as Director-Field Operations and we look forward towards the Field Organization being rejuvenated under his leadership.

Also joining us are our new BoD alternates, JoAnne Maenpaa, K9JKM and Steve Coy, K8UD. Alternates are fully engaged in BoD discussions but are non-voting. Our presumption is that a fully informed and engaged alternate is best prepared to assume a BoD position (until the next election) in the event a BoD member is no longer able to serve and resigns. As first alternate, JoAnne would be the next BoD member in the event of such resignation.

My thanks to the AMSAT members who took time to vote in this year's election. Election turnout was about par for the past few years even though the number of BoD candidates (8) was significantly higher than in past years. I am heartened by the number of candidates, suggesting that we have members who are committed to making a difference in terms of improving AMSAT's future and making a personal commitment to keeping amateur radio in space.

Moving Forward

AMSAT continues to make engineering strides as we prepare Fox-1 for the ELaNa-12 launch. Fox-1 has "grown" since it was first announced, now incorporating a camera built by students at Virginia Tech, and a new experiment provided by the Institute for Space and Defense Electronics (ISDE) at Vanderbilt University. The versatility of the Fox-1 design in supporting multiple payloads while serving as an amateur radio "repeater" will be demonstrated on this first flight. Successful demonstration of the Fox-1 class design will hopefully generate additional interest by universities and others in flying their payloads on this class of satellite. In essence, an "OSCAR in every cubesat" approach benefits both the university wishing to place their payloads on a reliable spacecraft design and amateur radio as this would expand the number of amateur radio satellites.

An additional benefit is the potential for placing Fox-1 telemetry and payload data in the classroom. The ground station software being developed in conjunction with the Fox-1 design is meant to support multiple goals: 1) payload support (the experimenter needs their data), 2) amateur radio operators (who will be receiving the telemetry using their home stations to forward this information to a central server) and 3) educators who can use the satellite status telemetry and scientific data in the classroom. One of the papers being presented at this year's Space Symposium is by Mark Spencer, WA8SME who is focusing on developing ways for educators to use the Fox-Class satellites to teach key scientific principles in the classroom. I look forward to seeing Mark's presentation at Symposium as he outlines "Three systems that are intended to make the experiments to be carried on board the Fox constellation of satellites more accessible to schools, teachers, students and hams".

I am well aware that many individuals long for the return of amateur radio to high earth satellite operations. Many view the operation of AO-10, AO-13 and AO-40 as the "highlight" of amateur radio satellites, with their highly elliptical orbits providing a large footprint and extended availability. There is no question that what makes extended communications possible is "location, location, location" and that HEO is preferred over LEO for the widest possible coverage.

High altitude satellites, however, come with high prices for launch services. Where amateurs want to place satellites in highly elliptical orbits do not necessarily coincide with current scientific or educational payloads which provide the justification for "others" to finance the launch of satellites that meet their needs. Consequently, we're "piggybacking" amateur radio capabilities on satellites whose justification is outside of amateur radio. The acceptance of Fox-1 and RadFxSat/Fox-1B in NASA's Expendable Launch of Nanosat (ELaNa) program was based upon scientific payloads, not amateur radio capabilities. The last we looked (several years ago), the cost to AMSAT of placing a Phase-3 class satellite into HEO would exceed $10 million, well beyond our means. We don't have the ability to raise those kinds of funds within the amateur radio community. Back in the 1990s, AMSAT raised over $2 million for Phase 3-D/AO-40, a significant accomplishment but nothing like what would be required in today's environment.

A key advantage of cooperating with universities focused on scientific payloads is that it offers opportunities for "education outreach." AMSAT-UK is likewise focusing on this approach with their FUNcube satellite scheduled to be launched this November. Their satellite, along with their ground station software, includes a provision for emulating a school classroom experiment ("Leslie's Cube") conducted by students throughout the UK to evaluate the differing radiation properties of different colored materials. As noted in AMSAT-UK's *OSCAR News*, conducting this experiment in space eliminates the influences of convection masking the radiation effects of heat transfer. FUNcube educational justification is the basis for flying the satellite.

continued on page 24 ...

Exploring the Fox-2 Maximum Power Point Tracking System

Mark Spencer, WA8SME, mspencer@arrl.org
ARRL Education and Technology Program Director

Rochester Institute of Technology (R.I.T.) engineering students have tackled the task of developing a maximum power point tracking (MPPT) system for use on the AMSAT Fox-2 satellite (see March/April 2013 *AMSAT Journal*). Their task was to prototype a system that optimizes the power delivered by the satellite's solar panels. I have previously published an article on a project to make the Fox-1 Attitude Determination Experiment accessible through a classroom simulator. Likewise, in this article, I continue my quest to make these Fox satellite experiments accessible beyond the handful of college engineering students who are directly involved in the developing the experiment to those schools, teachers, students, and the ham satellite enthusiast (you, the life-long-learner) who want to learn about the experiments and the fundamental concepts involved. Here you will find a project (simulator) that will allow you to explore the concept of MPPT, see an MPPT system in action, and observe how it behaves.

The need to optimize solar panel performance is not unique to space borne systems. Today's green energy initiatives highlight the need to gain every watt of power available from solar and other alternative energy sources. So the study and understanding of the MPPT concept has broad appeal, therefore the project described here is not limited to the Fox satellites. Also it must be recognized that there are many different approaches to solving the MPPT challenge, and the approach described here is just one approach. In fact, the approach you will read about is for academic, learning purposes only, and is not a system that is anywhere close to "flight ready." The system is developed to present the fundamentals "bluntly and obviously."

Solar Panel Basics

To begin, a review of some solar panel basics are in order, and I stress basics. A solar panel contains layers of stratified material that is sensitive to light and a solar panel will therefore produce a current when exposed to light. The amount of current produced depends on a number of factors but we'll look at just two; the intensity of the illumination hitting the surface of the solar panel (the number of photons) and the operating temperature of the solar panel (efficiency of the photon/panel interaction). The intensity of illumination is fairly intuitive, but what is interesting is that the efficiency of the solar panel goes up as the

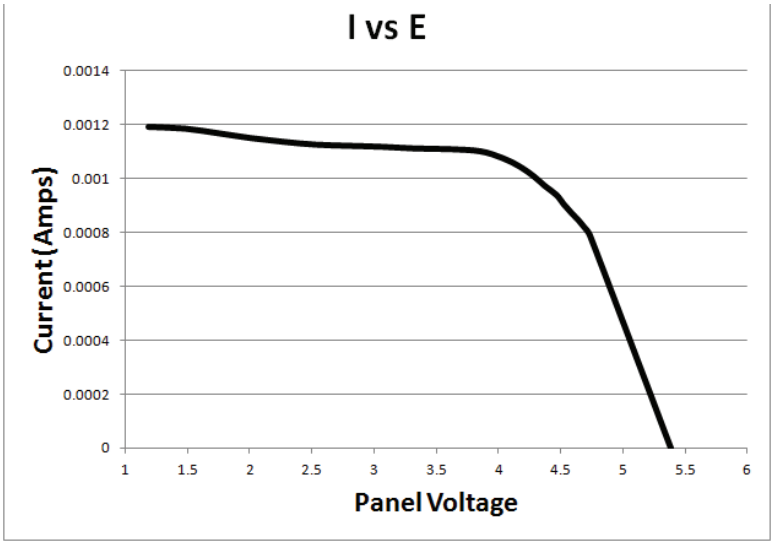


Figure 1

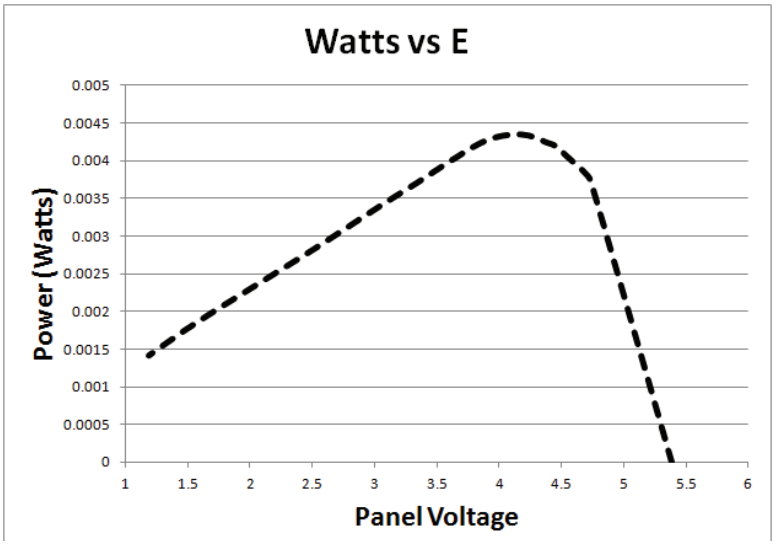


Figure 2

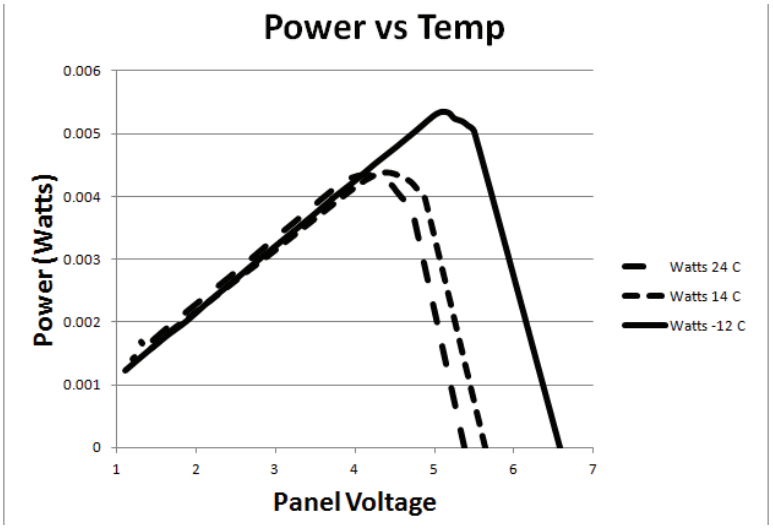


Figure 3

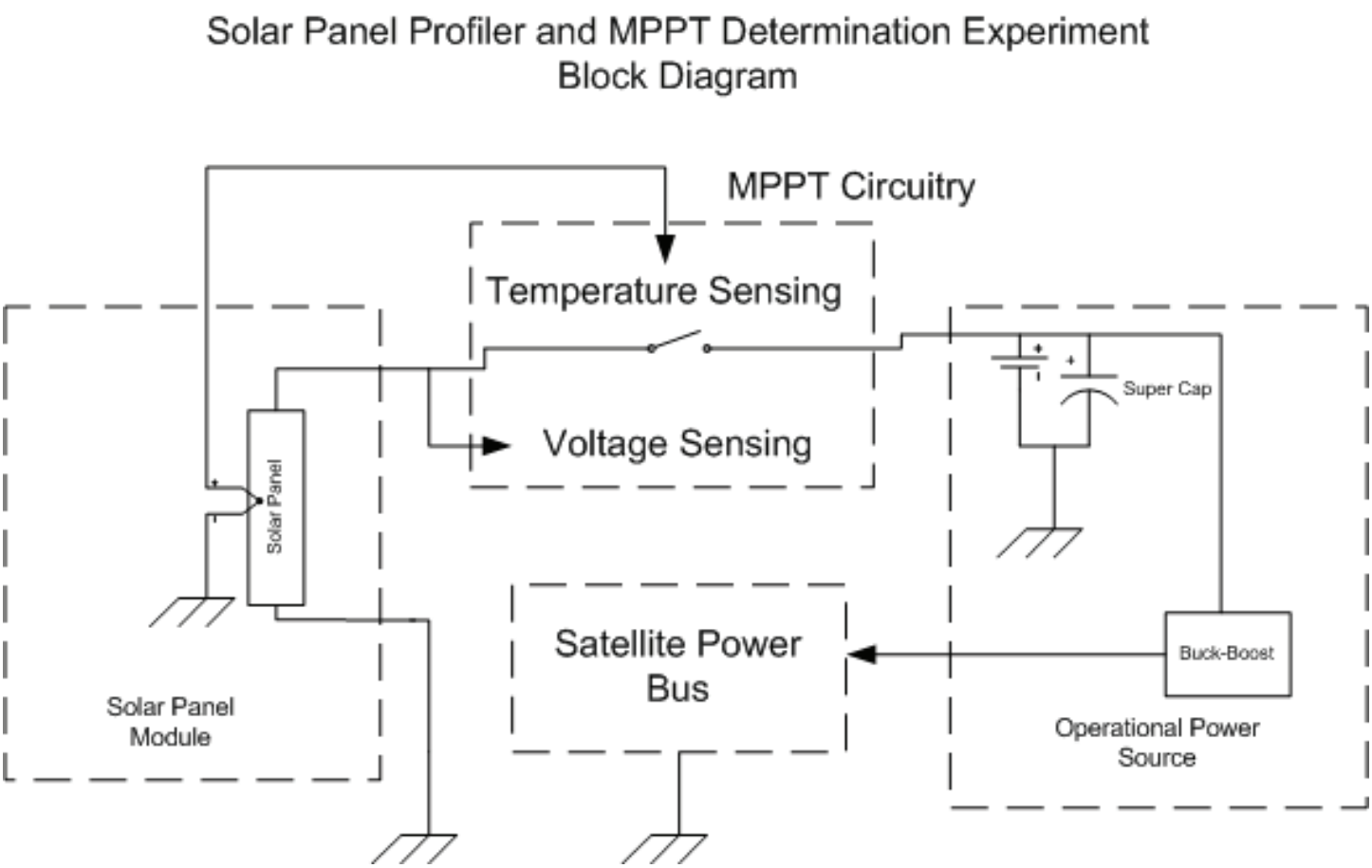


Figure 4

operating temperature goes down…the purpose of the MPPT circuitry is to adjust the solar panel operating point in response to changes in temperature to maximize operating efficiency.

Let's assume that we keep the two variables, light intensity and operating temperature, constant. When a solar panel is illuminated, with no load attached, the panel will produce a voltage (the open circuit voltage) however no power is produced because there is no current flow. If you attach a variable load (a variable resistor) across the solar panel, and measure the resistance as you adjust the resistor through its range and measure the corresponding voltage across the load, a graphic curve as depicted in figure 1 is produced. You need to use a little Ohm's law to calculate the current from the measured voltage and resistance. If you trace the plot of current vs. voltage, you notice that at zero current (open circuit) the voltage is around 5.5 volts, as the current flow increases (the load resistance decreases) the panel cannot produce enough current to hold the open circuit voltage level and the voltage drops down to virtually zero as the current demand increases. This voltage drop is because there are not enough photons of light striking the solar panel but also the drop can be

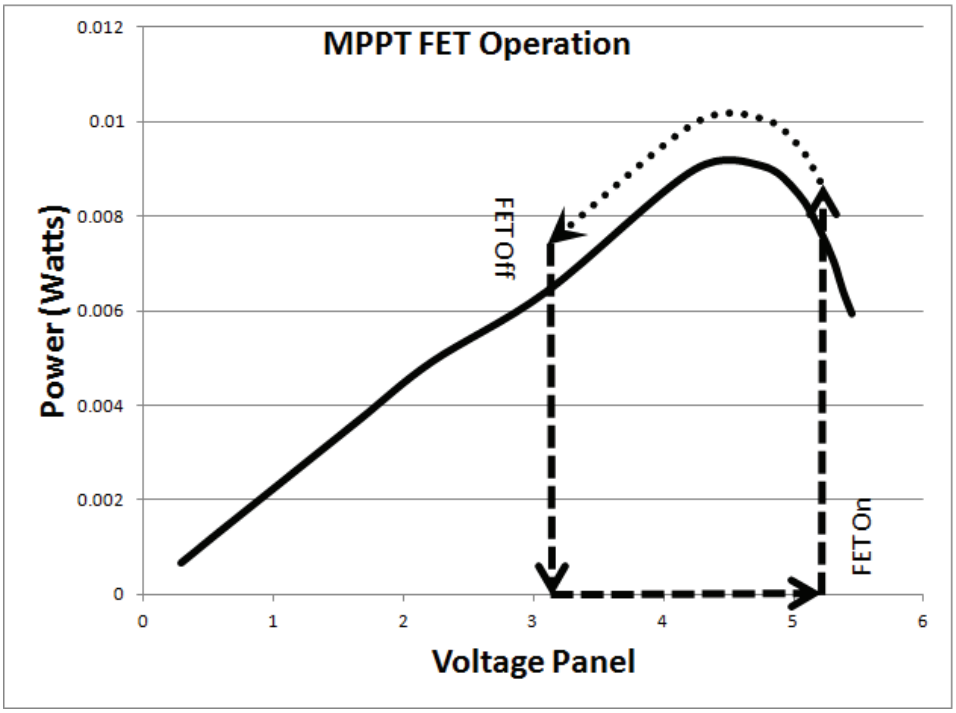


Figure 5

Solar Panel Profiler and MPPT Determination Experiment Jumper Set-up		J1	J2	J3
	Profile	---	XX	XX
	MPPT	XX	---	---
	--- = shorted XX = open			

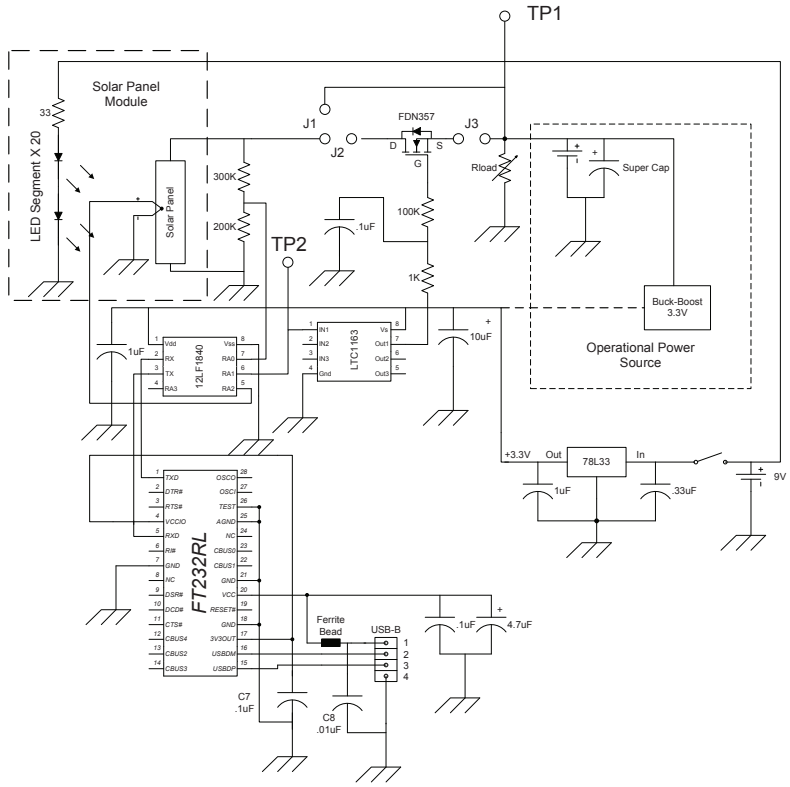


Figure 6

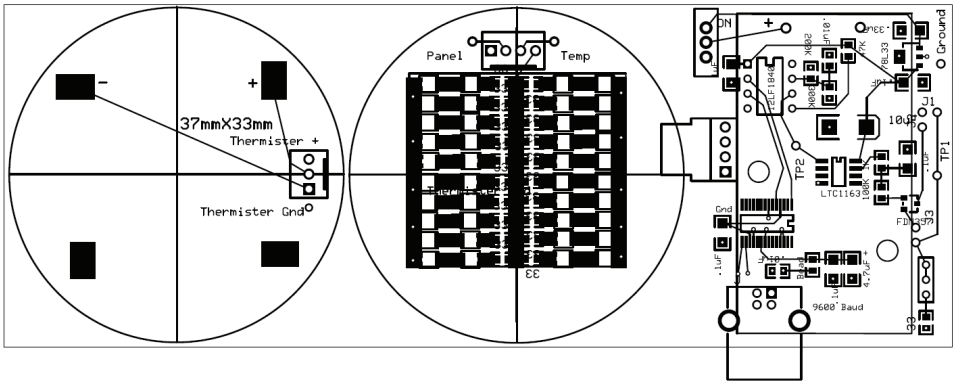


Figure 8, above

Figure 7

attributed to the internal resistance of the solar panel. This is an interesting look at the solar panel performance and useful for understanding solar panel behavior under load at constant illumination and constant operating temperature.

Now, let's apply some more Ohm's law and calculate the power produced by the solar panel as a function of the panel voltage. Figure 2 is a plot of power vs. voltage.

Notice that the power output of the panel peaks at around 4.25 volts. So under the fixed illumination level and operating temperature, the maximum power point (MPP) is 4.25 volts. If we were able to keep the load conditions (or the panel operating voltage) at or around the MPP, then the panel would be operating at peak efficiency…and this is the whole point of the MPPT.

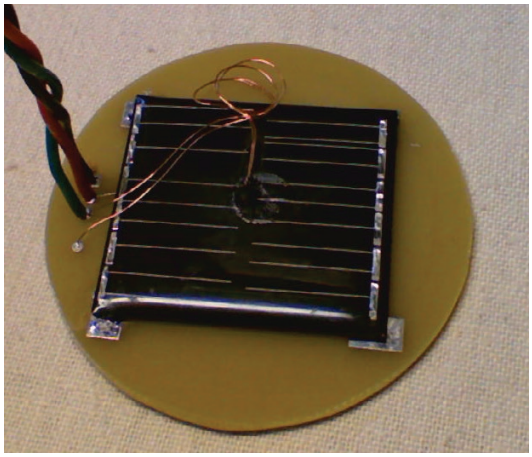
If we were to vary the temperature of the panel, another characteristic of a solar panel will come to light (pun intended), the panel efficiency improves as the temperature goes down. Figure 3 is a plot of three data sets collected at room temperature (24°C), in a refrigerator compartment (12°C), and in a freezer compartment (-12°C) of my household refrigerator. Notice the dramatic improvement of the solar panel output power when in the colder environment of a freezer.

MPPT Basics

To reiterate, in the most basic terms, the purpose of the MPPT circuitry is to adjust the solar panel operating conditions in response to changing panel temperatures to keep the panels operating at or near peak efficiency.

Figure 4 illustrates a simplified block diagram of the power components of a satellite. The left block represents the solar panels mounted on the satellite exterior surfaces that provide power for the satellite and replenish the battery/super capacitor power storage components when the panels are illuminated. The right block represents the batteries and/or super capacitors that provide power to the satellite during the eclipse portion of the orbit. Within this block is some sort of buck-boost power circuit that regulates the voltage from the battery to a level consistent with the operation of the satellite even if the voltage of the battery drops below the required voltage level. The power from the buck-boost circuit is connected to the satellite's central power bus for distribution. The upper center block represents the MPPT circuitry.

Within the MPPT circuitry are connections to temperature sensors and voltage sensors that are monitoring the operating conditions of the solar panels. The MPPT logic in turn toggles the solar panels on and off of the storage batteries in step with the sensor readings to keep the voltage output on the solar panels at or near the maximum power point (the sweet spot). Figure 5 graphically represents this MPPT process. When the solar panel voltage drops below a specific value, a FET switch opens to isolate the panel from the load. As the panel voltage rises under no load, the MPPT circuitry monitors the voltage rise. At the point when the voltage reaches a specific high voltage value, the FET switch is closed connecting the panel to the load. Continuing this cycle, as the panel voltage drops under the load, the MPPT control circuitry will open the FET switch when the voltage reaches the specified low value and the cycle repeats.



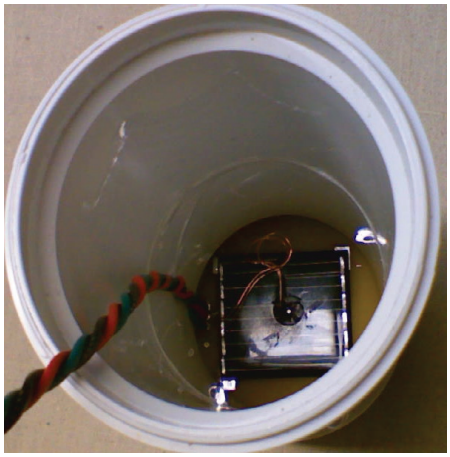
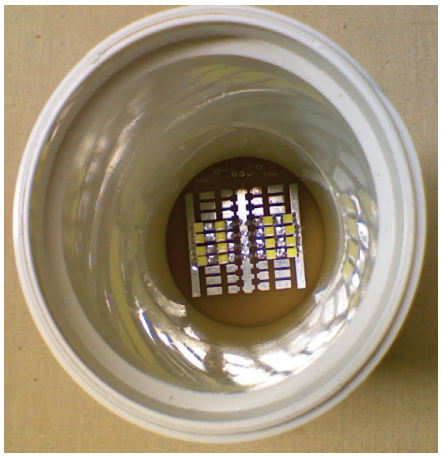


Figure 9



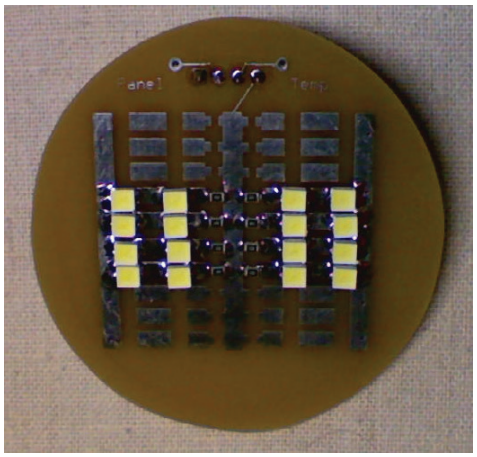


Figure 9

Simulating MPPT in the Classroom

The MPPT classroom simulator circuit diagram is depicted in figure 6. You will notice the similarity to the block diagram of figure 4. The main parts to the simulator include the solar panel (this is a hobbyist solar panel, not the panels actually used on the satellite) along with an illumination source and the MPPT circuitry with an interface to a personal computer (figure 7). The circuit board layout for this project is illustrated in figure 8, the solar panel and light source LED sections are cut and separated from the main board for mounting in the ends of a 1 ½ inch PVC compression coupler fitting. This arrangement allows the illumination source to be controlled by limiting the exposure of the solar panel to ambient light. Figure 9 depicts the solar panel mounted on the PCB and installed in one end of the compression coupler. Notice the thermistor glued to the center of the panel. Figure 10 depicts the LEDs installed on the illumination PCB and mounted in the other end of the compression fitting. The connecting umbilical wiring provides 9-volts to the illumination PCB and returns voltage from the solar panel and signals from the thermistor to the MPPT main board.

Using the MPPT system

There are two separate exercises that can be performed using the MPPT classroom system; solar panel profiling, and MPPT exploration.

Solar panel profiling

To develop a profile of the solar panel, the MPPT circuitry is isolated from the solar panel and the load (a 10-turn pot) by removing jumpers (figure 11). A VOM is connected to appropriate test points, and a USB cable is connected between the board and a PC running a GUI written for this project (and used here to measure the temperature of the solar panel figure 12). The compression coupler assembly is brought to the desired temperature by placing the compression coupler assembly in convenient temperature environments, for instance room temperature (around 20°C) and in your home refrigerator food (around 12°C) and freezer (around -14°C) compartments. The load resistance is set at specific resistance intervals (I recommend 250 ohm steps), power is applied to the illumination board, and panel voltage is measured with the VOM and recorded in a data table. This process is repeated through the load resistance range (6K to 1K ohms). The data is entered

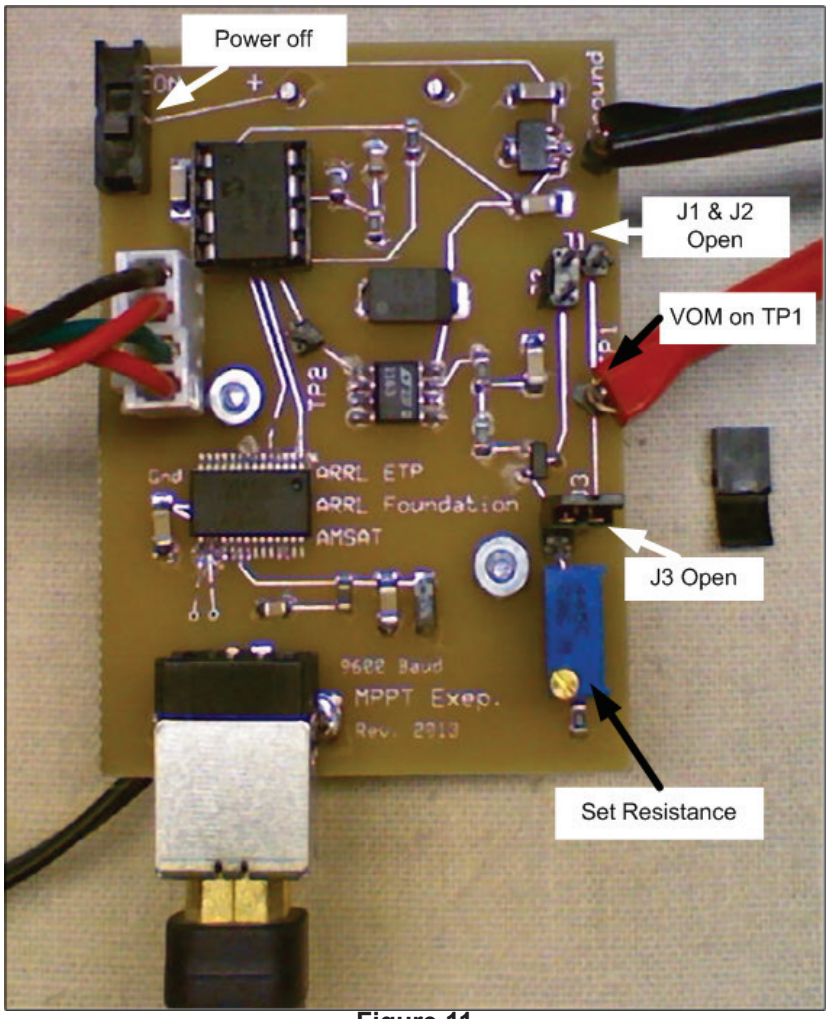


Figure 11

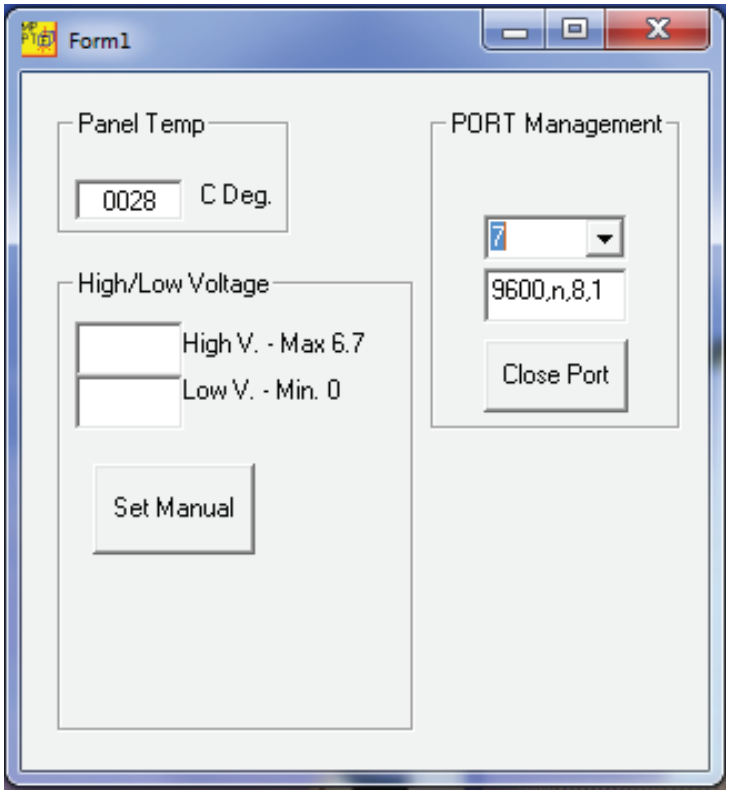


Figure 12

into Excel and the graphing capabilities of Excel are used to graph the data. Likewise the profile is accomplished for the other temperatures of interest. The end result of this activity would look something like figure 13.

By looking at the peak power output points and inserting this information into a graphing calculator, the algorithm for the relationship between solar panel temperature and maximum power point is determined. The MPPT formula for the prototype system is shown in figure 13. This algorithm is entered in the PIC program that is used in the MPPT logic for controlling the system in the automatic tracking mode.

MPPT Auto Tracking Mode

The central component of this MPPT circuit is a PIC® microcontroller. The analog to digital converter (ADC) resources of the PIC are used to monitor the temperature of the solar panel and the voltage produced by the panel. The temperature dependent, calculated optimum power point (from the algorithm developed during the profiling of the solar panel previously) is used to determine if a FET switch is turned on or off to either isolate or connect the solar panel to the load. The hysteresis of the FET switch activation above or below the MPP is pre-set in software when the PIC is programmed. The MPPT circuitry is connected into the circuit by jumping J2 and J3. An oscilloscope is connected to the FET controlling signal at TP2 and to the panel output voltage at TP3 (figure 14). On power-up the system operates in the auto mode. The MPPT system behavior is illustrated in the oscilloscope screen shot in figure 15. The bottom square wave trace is the FET switching signal, the upper saw tooth wave is the solar panel voltage. If you compare the actual waveforms produced by the MPPT circuitry in operation to figure 5 and the discussion earlier, you should be able to make the connection from the academic to the practical presentation of the MPPT concept.

The user can also observe the MPPT circuit behavior while responding to temperature changes by placing the compression coupler assembly in different temperature environments. The PIC is programmed to read the temperature at approximately 15 second intervals and make corresponding adjustments in the voltage hysteresis.

Manually Exploring MPPT

The GUI also allows the user to experiment with various high and low voltage settings to bracket the MPP and see the circuit's behavior (figure 16 and 17). The user can also monitor the MPPT circuitry as it responds to variations in load by adjusting the load resistor and observing the pulse width changes in response to the load changes and the corresponding change in the voltage slope when the panel is connected to the load.

Finally, the class can really get into depth of the MPPT operation and behavior by writing their own software to control the system.

Summary

There is a lot that can be learned from the study of the behind the scenes systems that make satellite communications possible, such as MPPT and Attitude Determination Experiment (Wobble). Additionally, there are lots of learning opportunities made possible by receiving and analyzing the telemetry data being transmitted by the satellites. From the academic and life-long-learner points of view, the Fox borne

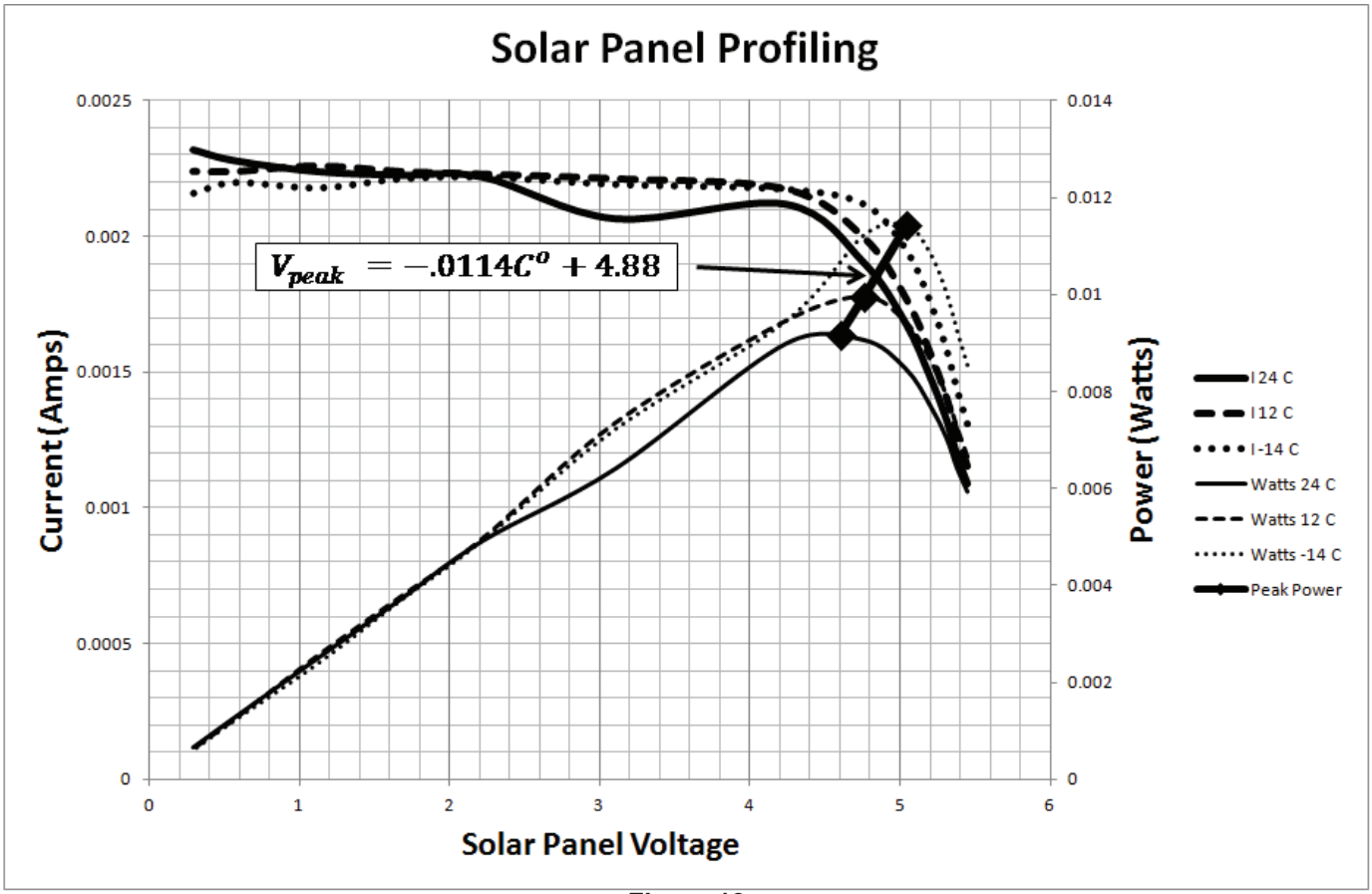


Figure 13

experiments are as important, if not more important, than the voice transponders they support. So I hope you will take some pass time to participate in the experiments, and become more proficient and capable satellite operators in the process.

As with the Wobble simulator project that was the subject of the companion article, this MPPT system project was made possible because of the generous support of the ARRL Foundation. I appreciate that they supported my own learning that resulted from the development of this project.

Questions? Let me know. Detailed operating procedures for using the MPPT classroom system are available, along with other detailed information that you will need to duplicate the project, is available from the author by a simple e-mail request to mspencer@arrl.org. Availability of kits/boards and that kind of thing are being considered. Watch the AMSAT web resources for news.

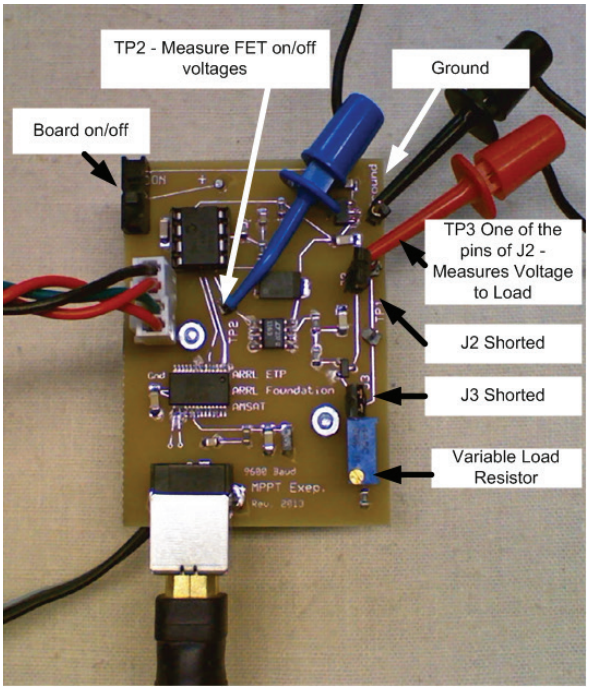


Figure 14

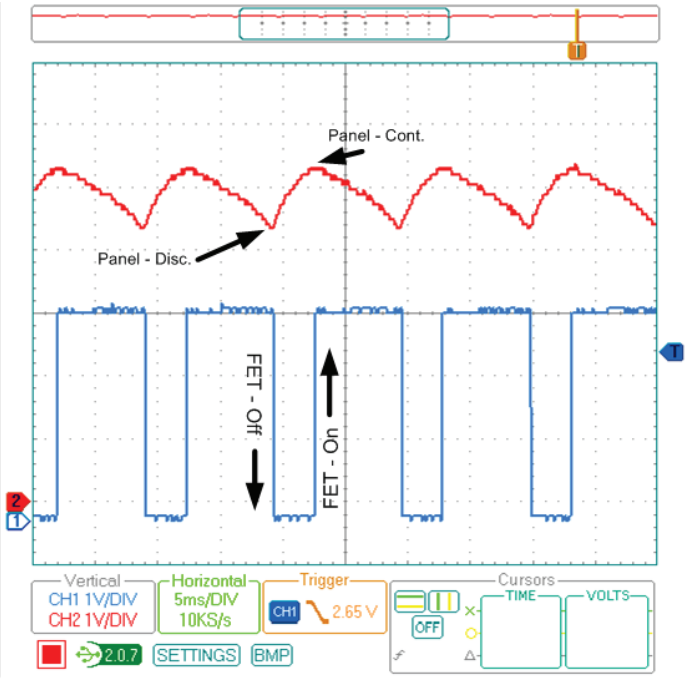


Figure 15

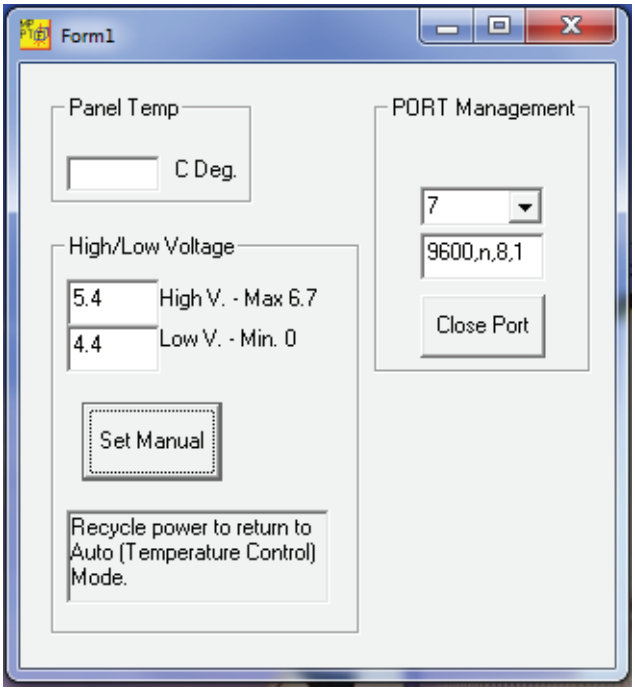


Figure 16

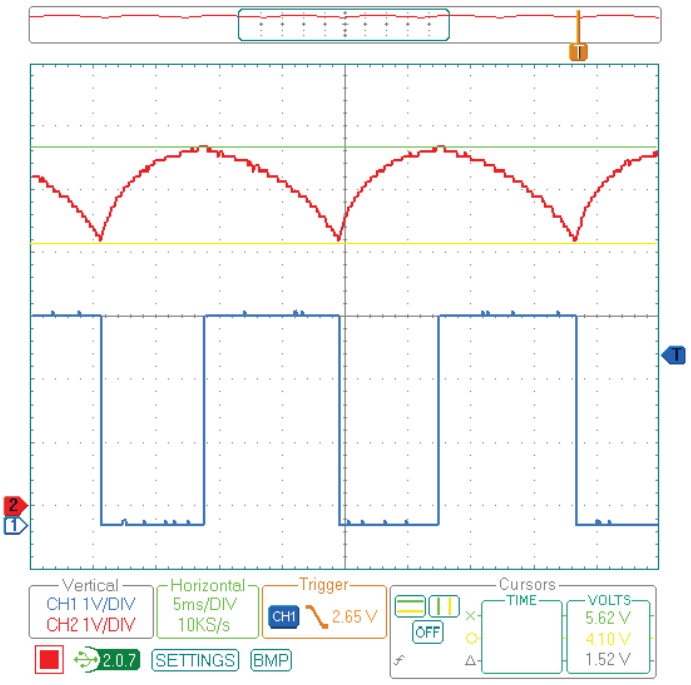


Figure 17

W7LRD Grid Expedition to CN77

Bob Johnson, W7LRD
w7lrd@comcast.net

Many of us know we "should" be balanced in our lives and hobbies. Nothing can be further from the truth when it comes to ham radio. Ham radio by its nature can be very time consuming. When my dear XYL suggested we take a two day trip to the ocean with our 8 year old granddaughter, and two dogs my thoughts went to... "that's the rare grid square of CN77! Why I know many sat ops who would like to check that one off!"

Planning and "delicate" negotiations were required. I considered my handheld with my arrow antenna. After a few attempts on SO-50 in the back yard that seemed rather futile. I ran some wire from the car battery to my IC-910 which I connected to my arrow bungie corded to a camera tripod, tested it out in the driveway, and worked John, K8YSE on FO-29 with ease.

Now the die was cast, between the XYL wanting to check out every gift shop in town, my dear granddaughter wanting to fly a kite all day on the beach, and dogs requiring numerous potty trips and me needing to "squeeze" in satellite passes.

A few carefully chosen FO-29 passes with notification via the AMSAT-BB created a 20 meter-like pile up in my direction. Drew, KO4MA told me this roving can be addictive. He's right. Drew was also my best DX from the west coast of Washington to the west coast of Florida.

Don't get me wrong, I love my wife of 43 years, and my 8 year old granddaughter, and of course my puppies. However, if this is going to happen again, they all stay at home. Check out the common border with CN76 and CN77. I already know where it is!! All I need is a couple of better antennas, then configure my laptop and tracking software with my az/el rotors which I'll prop up in the back of my pickup. I recall John, K8YSE did this awhile back around Lake Michigan. Planning, planning and more planning is essential for a successful effort. Thank you my many satellite friends for opening this aspect of radio. After 52 years it just never gets old.

Bob and one of his pups get ready for AOS on FO-29

Bob working an evening pass on FO-29

(left) Mrs. Johnson always knew where to find Bob.

(right) Kite flying on the beach. (Wonder if that kite can loft an antenna?)

AMSAT-UK Prepares for November Launch of FUNcube-1

AMSAT-UK announced their FUNcube-1 CubeSat has now completed all its final testing and been placed into its launch POD. This work was completed during a three day programme at the premises of ISIS BV in Delft in the Netherlands and was finished, on time, late Wednesday afternoon on September 4, 2013. The planned launch via a Russian Dnepr rocket from Yasny is in November, 2013. This launch may carrying up to 23 satellites from 13 nations.

FUNcube-1 carries a U/V linear transponder and the educational telemetry beacon using 1k2 BPSK for school outreach purposes.

FUNcube-1 communication subsystem

- 400 mW Inverting linear transponder for SSB and CW
    - Uplink 435.150 – 435.130 MHz
    - Downlink 145.950 – 145.970 MHz
- 400 mW BPSK Telemetry 145.935 MHz

A recent presentation about the FUNcube project by Graham Shirville G3VZV and Wouter Weggelaar PA3WEG can be viewed online at:

http://www.batc.tv/streams/amsat1311

FUNcube project information and educational outreach information sheets can be accessed at the AMSAT-UK web:

http://amsat-uk.org/2013/09/04/funcube-1-is-in-its-pod/ - and - **http://amsat-uk.org/funcube/funcube-cubesat/**

The FUNcube website can be viewed at: **http://www.funcube.org.uk/**

Some of the other satellites that may be on the same Dnepr launch vehicle are listed at:

http://amsat-uk.org/2013/08/22/dnepr-cubesat-launch/

New Version!

AMSAT is the North American distributor of **SatPC32**, a tracking program designed for ham satellite applications. For Windows 95, 98, NT, ME, 2000, XP, Vista, Windows 7.

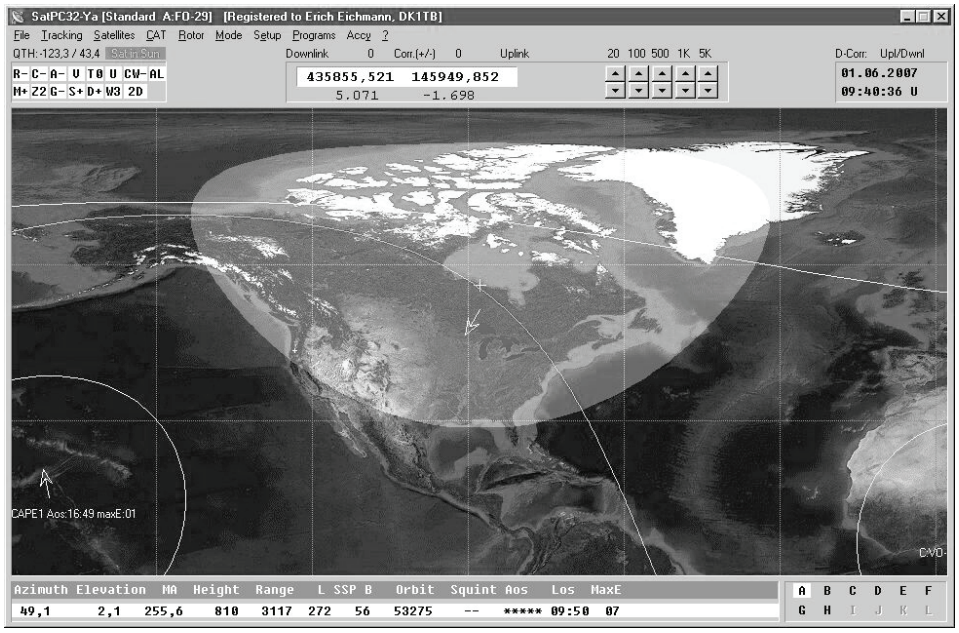
Version 12.8b is compatible with Windows 7 and features enhanced support for tuning multiple radios.

Version 12.8b features:

- SatPC32, SatPC32ISS, Wisat32 and SuM now support rotor control of the M2 RC-2800 rotor system.
- The CAT control functions of SatPC32, SatPC32ISS and Wisat32 have been expanded. The programs now provide CAT control of the new Icom transceiver IC-9100.
- The main windows of SatPC32 and SatPC32ISS have been slightly changed to make them clearer. With window size W3 the world map can be stretched (only SatPC32).
- The accuracy of the rotor positions can now be adjusted for the particular rotor controller. SatPC32 therefore can output the rotor positions with 0, 1 or 2 decimals. Corrections of the antenna positions can automatically be saved. In previous versions that had to be done manually.
- The tool 'DataBackup' has been added. The tool allows users to save the SatPC32 program data via mouse click and to restore them if necessary. After the program has been configured for the user's equipment the settings should be saved with 'DataBackup'. If problems occur later, the program can easily restore the working configuration.
- The rotor interfaces IF-100, FODTrack, RifPC and KCT require the kernel driver IOPort.SYS to be installed. Since it is a 32-bit driver it will not work on 64-bit Windows systems. On such systems the driver can cause error messages.To prevent such messages the driver can now optionally be deactivated.
- SuM now outputs a DDE string with azimuth and elevation, that can be evaluated by client programs. Some demo files show how to program and configure the client.

Minimum Donation is $45 for AMSAT members, $50 for non-members, on CD-ROM.
A demo version may be downloaded from http://www.dk1tb.de/indexeng.htm
A registration password for the demo version may be obtained for a minimum donation of $40 for members and $45 for non-members.
Order by calling 1-888-322-6728.

The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.



2013 AMSAT Field Day Results

Bruce Paige, KK5DO, kk5do@amsat.org
AMSAT Director Contests and Awards

This year, there were plenty of stories about Murphy visiting and some not only once. Based on previous years, you would think the run for the brass ring would be a close one. Actually, the run for second place was a close one and first place was a no contest slam dunk.

Table 1 shows all entries received. In the case of a tie, the call signs are listed alphabetically.

This year, AO-27 was MIA and SO-50 was really the only FM satellite. It was slammed and one group reported they attempted to make a contact over SO-50 and was simply unsuccessful, period.

This year, there were 8 satellites in use. I count the satellites based on their modes as you can make contacts using both modes. SO-50 has one FM transponder and I count that as one satellite whereas AO-07 has two modes, SSB and CW and gets counted as 2 satellites.

We had the most satellites in use back in 2009 and 2010 with 12 different satellites. In 2011 and 2012, we had 9 different satellites and this year we only had 7.

The number of participating AMSAT Field Day stations has remained pretty constant over the years as evidenced by Table 2. This year we have broken our participation record by two stations. QSO count was way up.

Table 1: 2013 AMSAT Field Day Results

Place	Call	Class	QSOs
1	W6YX	9F	104
2	W0GQ	2A	79
3	W5MSQ	2A	76
4	W9LDX	1A	76
5	K4LRG	5A	51
6	K6MMM	3A	44
7	K4BFT	4A	36
8	W0PNA	1A	20
9	CO6CBF	1B	18
10	W5PFG	1E	17
11	K6AA	3A	16
12	K8UNS	4A	11
13	W6NWG	5A	11
14	VE3SAR	3A	10
15	K2WNY	1B	9
16	WQ9A	3A	9
17	W5IU	4A	8
18	K5AXW	1AB	4
19	N7A	1A	4
20	W0WTN	4A	4
21	WC5C	4F	3
22	KO6TH	1D	2
23	K6CLX	2AB	1

Table 2: Summary of Entries Submitted by Year

	2006	2007	2008	2009	2010	2011	2012	2013
Satellites	10	7	8	12	12	9	9	7
QSO's	258	207	220	328	387	335	263	443
Stations	21	13	17	20	18	14	19	23
Points	327	207	270	486	505	455	329	613

Table 3: Summary of QSO's per Satellite

SO-50 Phone	AO-7 Phone	FO-29 Phone	VO-52 Phone	AO-7 CW	FO-29 CW	VO-52 CW	ISS APRS
12	101	164	81	29	34	19	3

Also this year I added the number of total points submitted by all stations together. I will explain the change in QSO count and total points a bit later.

As with every year, who was the number one station at Field Day. This year, moving up from 3rd place last year is the Stanford University Amateur Radio Club, operating as W6YX, with a whopping 104 points. Second place is Cedar Valley Amateur Radio Club, W0GQ, with 79 points. We had a tie for third place between (alphabetically) the Houston QRP Club, W5MSQ (dropping from 2nd place last year) and Lafayette DX Association, W9LDX, both with 76 points.

Last year's number one station, K6MMM dropped to 6th place this year. Hector, CO6CBF, (picture 7 along with Lazaro, CO6TW) operating portable and the only station outside the U.S. and Canada to report was in 8th place with 18 points operating under battery power. Hector also participated last year. Others operating with battery power were Los Chupacabraderos, K5AXW, and Calexico Amateur Radios Society, K6CLX. Those at the Western New York QRP Society, K2WNY, used 5 watts solar power at their site and it was their first satellite field day.

There were no stations operating from home with emergency power this year.

The 8 satellites in operation this year were SO-50 (FM), AO-07, FO-29 and VO-52 (all in SSB and CW), and the ISS (in APRS). Yes, three stations, WC5C, W6YX and CO6CBF chose to listen for the ISS and made one APRS contact.

Breaking down the contacts, FO-29 phone carried most of the Field Day contacts with 164 reported.

One of the more interesting photos received this year was from the San Lorenzo Valley Amateur Radio Club. They were operating from a horse trailer (picture 1). In picture 2, you can see the trailer the Houston QRP Club, W5MSQ, used and the visitors they had (picture 3).

At the Palomar Amateur Radio Club, W6NWG, site, Art, KC6UQH, did their satellite contacts. The beautiful scenery in picture 4, not the mountains or the brush silly, the antenna, belongs to the Amargosa

(left) Picture 1

(right) Picture 2

(left) Picture 3

(right) Picture 4

Amateur Radio Club, N7A.

The Loudoun Amateur Radio Club, K4LRG, sports the comfortable station and antennas in pictures 5 and 6 where the weather was excellent and the old but sturdy workhorses had a purpose.

The Peruvian American Radio Club, W0PNA, had a visit from Murphy with connector issues and a tripod failure which caused them to miss half the available passes. Perseverance and a little fixing put them back in the hunt.

Tri-County Amateur Radio Club, WC5C, had a nice station and their TS-2000 went "stupid" according to Thomas, KE5UUO. The station setup was nice as you can see (picture 8). The Cedar Valley Amateur Radio Club, W0GQ, (picture 9) was on a nice hill in the middle of town.

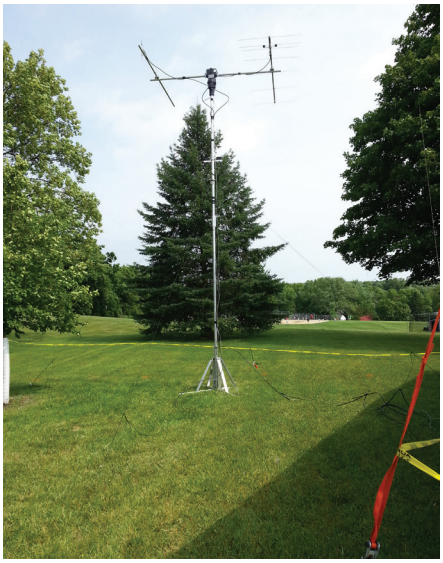
So, how did the number one station this year do it? How did they score way over any station since I have been tracking statistics? What was their secret weapon? The Stanford University Amateur Radio Club, operating as W6YX, used an ICOM 821 for the TX and RX. Here is their story as told by the W6YX Field Day satellite team members.

Using a SDR allowed us to not only get a competitive advantage, but also share the experience with more people and explore the experimental nature of the hobby. A ~$15 entry point RTL E4000 SDR, ~$25 worth of UHF and VHF filters from the local ham flea market to place between our preamp and SDR, plus a $1 cable TV bias-T upgraded and converted to 50 ohms, led to a worthwhile investment and a win-win for W6YX, our members, and guests alike.

Picture 10 is a screen shot of FO29 at 0437z during Field Day. The software is HDSDR which includes instructions on their website [1] on how to interface via DDE to HDSDR, Orbitron and other popular satellite tracking programs for automatic Doppler compensation of the SDR.

Trained eyes can easily spot eight SSB stations and seven CW station. A SDR not only allows one to record and play back the entire transponder, but it also provides much better resolution and customization compared to the pan-adapters provided by several radio manufacturers.

Picture 5



Picture 9

Picture 6

Picture 7

Picture 11 is a screen shot of the hectic 2213z AO-7 pass using the advance SDR program Linrad. Linrad is by far the most versatile and best performing SDR program available today. Its waterfall sensitivity, noise blanker and AGC [2] cannot be matched by any other software available. No other SDR program comes close. As expected, with such a powerful program, a deeper understanding of how radios and computers work is required to utilize the given performance advantage Linrad provides. A look on Linrad's main spectrum waterfall shows several SSB and CW stations. The "squiggly" lines are a linear satellite operator's favorite. They're the CW operator that cannot hear their own downlink, so they hold down their paddle while wiggling their VFO knob back and forth to ensure they QRM every single QSO taking place on the transponder (which they can't hear, but know are taking place). The intermittent horizontal splatters on the waterfall are QRM from an adjacent APRS DX packet network. The 2m ham band is very crowded in Silicon Valley and the SSB Electronics preamp we have uses vintage GaAs FETs with very limited IP3 compared to modern LNAs based on cutting edge GaAs pHEMT MMICs such as ones used by LNAs AD6IW produces [3]. The only drawback being wide-band MMICs require narrow bandpass filter on their output. The lack of the SSB Electronics IP3 performance when used in a RF heavy environment can be easily as horizontal smears on the waterfall, pointing out yet another advantage of a SDR, helping identify weak links and QRM sources in your receiver system.

John, KJ6ZL, from the San Lorenzo Valley Amateur Radio Club, K6MMM, said "Regardless of point count, the Satellite Station is always a major crowd pleaser for our Field Day." Editor: I don't know why that is but almost anytime you make a contact by pointing a silly antenna around at the sky, onlookers think it is amazing. You can make 10,000 contacts on HF, but that one satellite contact does the trick.

Ted, K9KQQ, operating from the Milwaukee Repeater Club, WQ9A, summed it up the best, "Using no preamps and a simple cheap yagi antenna is a different experience from the home station. This is what field day is for, learning to work with less."

Next year, as I have said many, many years before, I hope that we have even more participants in the AMSAT Field Day. Hopefully, Murphy will not visit your Field Day site. But if he does, be prepared.

Reference - Adding SDR to Field Day Operating

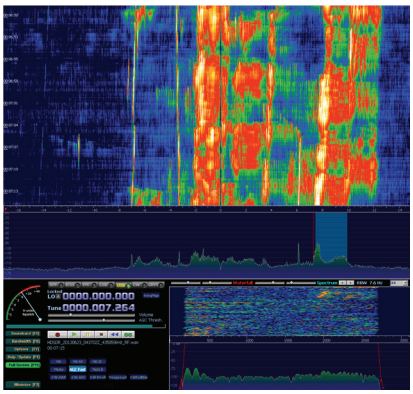
[1] HDSDR DDE client for Ham Radio Deluxe, Orbitron, WXtrack, SatPC32 and Wisp
http://hdsdr.de/hdsdr_dde.pdf

[2] SM5BSZ Testing AGC in receivers
http://www.sm5bsz.com/lir/agctest/agctest.htm

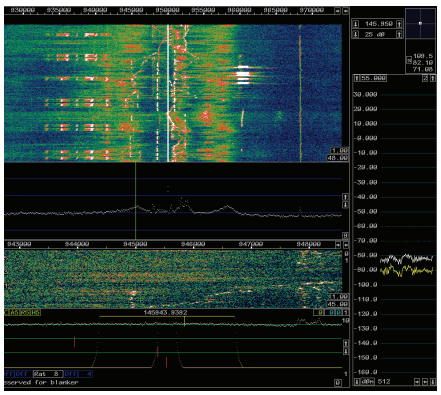
[3] AD6IW HIGH INTERCEPT LOW NOISE AMPLIFIER with GaAs pHEMT MMIC
http://www.newsvhf.com/hemt-mmic-wideband-lna.pdf
http://amsatindia.org/Newsletter/AMSATINDIA-News-May_2011.pdf

Do you think your station will add SDR next year? Looks like the time is right. Last year, the San Lorenzo Valley Amateur Radio Club, K6MMM, used their SDR to take the winning spot.

Picture 8



Picture 10



Picture 11

Museum Ships Weekend 2013 - Satellites and a Balloon

Andy MacAllister, W5ACM, w5acm@amsat.org
and Allen Mattis, N5AFV, n5afv@amsat.org

This was the sixth year of the Brazos Valley Amateur Radio Club (BVARC) participation in the annual Museum Ships Weekend Event (http://www.nj2bb.org/museum/index.html) sponsored by the Battleship New Jersey Amateur Radio Station on June 1-2, 2013. This event always provides an excellent opportunity to demonstrate the OSCAR satellites and Amateur Radio. During the weekend event Amateur Radio operators activated radio stations on 106 museum ships worldwide, up from the 99 ships that participated last year. Approximately 65% of the museum ships were located in the United States; however, museum ships in Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Netherlands, Norway, Portugal, Russia, Spain, Sweden and the United Kingdom also participated. Twenty six of the US states participated in MSWE with California having twelve ships, Michigan nine and Texas eight. Amateur Radio operators who contacted any fifteen of these ships qualified for a handsome certificate.

During the event the Brazos Valley Amateur Radio Club (BVARC) operated club station KK5W from Seawolf Park on Pelican Island in Galveston, Texas. Seawolf Park is home to two Second World War vintage museum ships - the destroyer escort USS Stewart (DE-238) and the submarine USS Cavalla (SS-244), nicknamed the "Lucky Lady" by submariners. As a result, a contact with KK5W counted for two ships. BVARC operated from four locations within Seawolf Park. The radio rooms on the two ships were used for operation on the HF bands primarily using CW. The radio rooms on the ships contain a considerable amount of vintage radio gear that is no longer operational, but serves as a museum display. The Amateur Radio operators brought along their own equipment, but did use the long wire antennas that have been restored on both ships. Two additional operating locations were set up in picnic shelters adjacent to the ships for making primarily HF sideband, VHF FM and satellite contacts.

The satellite gear was relatively simple, but more than just an HT with a long whip, or a mobile radio with a handheld beam antenna

Figure 1 - Destroyer Escort USS Stewart (Photograph by Travis Burgess K5HTB)

Figure 2 – Submarine USS Cavalla (Photograph by Travis Burgess K5HTB)

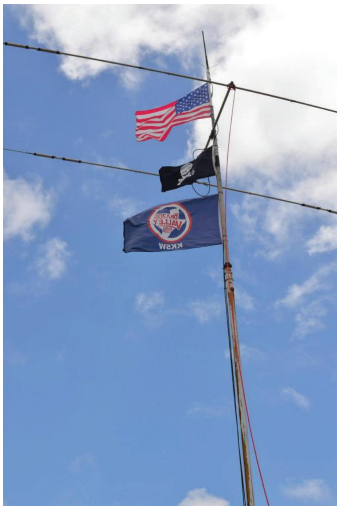


Figure 3 – Flags Waving in the Breeze (Photograph by Carl Hacker WC5WM)

Figure 4 – Andy W5ACM Working an FO-29 Pass (Photograph by Travis Burgess K5HTB)

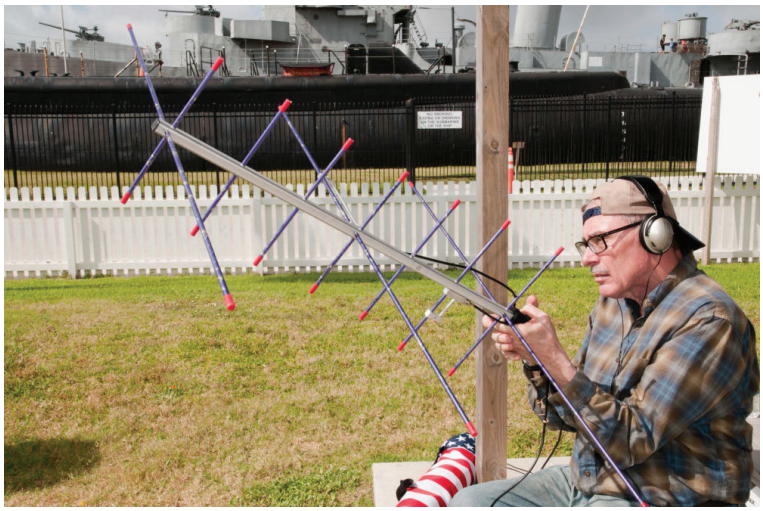


Figure 5 – Allen N5AFV Tracking FO-29 with Arrow Antenna (Photograph by Travis Burgess K5HTB)

Figure 6 – FO-29 LOS behind the USS Cavalla (Photograph by Travis Burgess K5HTB)

Figure 7 – KK5W MSWE Satellite Team (Left to Right) Charlie Keng K5ENG, Carl Hacker WC5WM, Mike Scarcella WA5TWT, and Andy W5ACM (Photograph by Travis Burgess K5HTB)

held out the window. A Yaesu FT-847 was used with an Arrow antenna without duplexer for all operations. A large gel-cell battery was quite sufficient for the Saturday afternoon activity. A second identical battery was available if needed. Allen, N5AFV, coordinated each pass and handled the Arrow antenna, while providing time and pointing angle information to station operator Andy, W5ACM. Charlie Keng, K5ENG, Carl Hacker, WC5WM, Mike Scarcella, WA5TWT, and Tom Matthews, K5SAF, helped with everything else at the satellite station. The arrangement worked very well. Three headsets were parallel wired so that each of the crew could hear the downlink, but avoid audio feedback issues associated with using a speaker. The sea-side location gave excellent horizon-to-horizon coverage in almost all directions.

Two passes of FO-29 and one pass each of SO-50 and AO-07 were worked. A total of 22 satellite contacts were made with stations in 15 US states and Canada. There were 11 contacts on SO-50, 10 sideband contacts on FO-29 and one CW contact on AO-07.

An added bonus this year was the launch of the N5BPS-11 balloon from Seawolf Park. Thomas Krahn, KT5TK, flew a 300 gram helium latex balloon with APRS data on two meters and a cross-band linear transponder featuring a 70-cm uplink coupled with a 10-Meter downlink. Sensitivity was lower than desired on the transponder, but it did work. The total payload weighed only a few ounces and will be tried again on another balloon later in 2013. The N5BPS-11 balloon reached an estimated altitude of 101,000 feet and one of the balloon packages was later recovered near Dayton, Texas approximately fifty miles to the north of Seawolf Park.

During the flight, it seemed that the cross-band transponder was interfering with GPS reception. Without accurate data, the landing position was unknown. However, Thomas received a welcome surprise two weeks after the flight when he got a call on his cell phone from someone who mentioned that he has found a “little white box”. Thomas was in traffic at the time and his German accent was not quite compatible with the caller’s Spanish accent. Communication was difficult, but thanks to subsequent “texting” between Thomas and Nuriel in Dayton, a

meeting was arranged at Nuriel's home.

Apparently Nuriel's father was working in a field near Anahuac, Texas, when he saw the "little white box". Unfortunately the second payload box and the miniature video camera were not seen. Nuriel was very interested in the science and experimentation associated with the flight. Thomas showed him the launch video and a few pictures. The other pieces of the three-piece payload have still not been located, but if Nuriel's dad goes back and has a second look, Nuriel and Thomas may need to get back to "texting". With the original transponder in hand, the group can effect appropriate circuit upgrades and fly again.

During the first two years that BVARC participated in the Museum Ships Weekend Event KK5W was the only station to operate on the satellites. For the past four years satellite operators on other museum ships have participated. Last year KK5W worked three other museum ships on OSCAR satellites, however this year we were able to copy the USS Orleck on an FO-29 pass but could not complete a contact with them. As in past years it was very enjoyable and rewarding to participate with the Brazos Valley Amateur Radio Club (BVARC) in the annual Museum Ships Weekend Event and we were delighted to see other satellite operators participating in what is becoming a significant world-wide Amateur Radio event.

Figure 8 – Andy W5ACM with WWII Vintage 75m Handheld Making a Terrestrial Contact (Photograph by Travis Burgess K5HTB)

Figure 9 – Darrell KC5JAR and Thomas KT5TK while others look on during the filling the N5BPS-11 Balloon with Helium. (Photograph by Carl Hacker)

Figure 10 – N5BPS-11 Launch Crew in Position. Darrell KC5JAR with the balloon and Mike WA5TWT ready to let go of the main payload (Photograph by Allen Mattis N5AFV)

Figure 11 – N5BPS-11 Balloon Airbourne (Photograph by Travis Burgess K5HTB)

Figure 12 – Nuriel returns N5BPS-11 Balloon package found by his father in a field to Thomas Krahan KT5TK (Photograph by Sven Steudte AF5LI/DL7AD)

Kitty Litter Radio Carrier for Portable Operation

Randy Hall, K7AGE
k7age@arrl.net

Randy, K7AGE sent photos showing how he mounted his Yaesu FT-857, antenna tuner, and soundcard interface inside of one of those plastic buckets that bulk kitty litter is sold in.

Since these photos were taken he has mounted a KPC-3 TNC above the radio to work ISS packet on 145.825 MHz. He uses an Elk antenna for portable operation.

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4) Complete unit - board, USB output, rotor cable, LCD, enclosure - $200 + S&H **our most popular

Documentation for the LVB Tracker can be found at: http://www.LVBTracker.com

Boards and complete units may be ordered from the AMSAT office at 301-589-6062 or from martha@amsat.org

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Choose where your contribution should go:

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❒I prefer to make my donation in one yearly payment of $_____

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THANK YOU!

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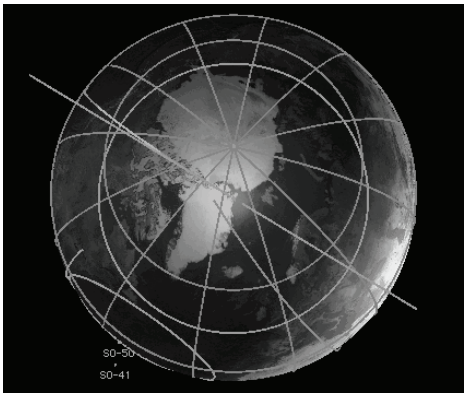

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Apogee View - continued from page 4 ...

We're focusing on programs that take advantage of the university partnerships that we've developed; that is why Mark Spencer's efforts in translating concepts into practical educational materials is so important. If we're able to develop a track record of success both in terms of the Fox-class design for supporting scientific payloads as well as developing educational outreach materials that make it possible for educators to benefit from using our satellites in the classroom, we can then build upon these achievements.

Any not-for-profit organization that expects to attract major contributors to a potential capital campaign must not only outline a vision that excites the donors, but also demonstrates the ability to achieve those goals. A successful "track record" with our Fox-class satellite program builds confidence and a reputation for accomplishment. Over time, based upon a successful Fox-class program, we can then develop a "Case for Support" to go to non-amateur donors and encourage their financial support of our projects that are focused on non-amateur goals, such as educational outreach and scientific research. Perhaps this approach is one way to gain the funds necessary to be able to pay for more ambitious satellite projects sometime in the future. Major donors are not interested in whether a satellite will allow amateurs in the US to talk to amateurs in Europe or Asia, but if we can demonstrate a scientific and/or educational benefit of an AMSAT satellite that does have a higher apogee, perhaps we will create an opportunity for applying AMSAT's satellite skills for a new purpose that excites major donors. The key, however, is demonstrated success in designing/building successful satellites that achieve their objectives.

I note this not because there are any prospects at the moment for a project larger than cubesat, but to highlight the fact that what we accomplish over the next 4-5 years with our Fox-class satellites may create the foundation for future possibilities.

Success breeds success.

AMSAT Recognition

Each year I look forward to the AMSAT Annual Meeting because it provides an opportunity for the AMSAT leadership to recognize the key accomplishments of our volunteers that make a difference for the organization. There are many individuals who do much for AMSAT in a variety of areas and disciplines. We are fortunate to have an Engineering Team focused on getting Fox-1 ready for delivery to CalPoly in May 2014, but our volunteers cover a much broader scope.

Think about the services that AMSAT provides, such as publications (The *AMSAT Journal*, "AMSAT New Service", books such as Getting Started on the Amateur Radio Satellites), Electronic Services (Website, AMSAT Store, E-Mail services), Contests and Awards, ARISS Operations, AMSAT presence at hamfests (Forums and booth operations), Club Presentations (by Area Coordinators and others), as well as the daily management of the organization. AMSAT succeeds because we have dedicated volunteers who make a difference.

As we take the time to recognize key individuals who made a significant difference at the upcoming Annual Meeting, I ask that you think about the specific AMSAT volunteers that you may interact with directly, and take a moment to thank them for their service. We can only scratch the surface by recognizing the impacts of our volunteers during the Annual Meeting, so taking the time to thank our volunteers is important.

Whether it is the volunteer who is manning a table at a hamfest that you're attending, or someone that you're exchanging e-mail, take a moment to say "Thank you." Every AMSAT volunteer is using their time and talent to help AMSAT keep amateur radio in space. By your taking a moment to acknowledge these individuals, you help to affirm the efforts of these dedicated volunteers.

New Items in the AMSAT Store ... http://store.amsat.org/catalog

New 2013 AMSAT Golf Shirt (Powder blue)

New 2013 AMSAT Hat (light blue)

New 2013 Fox Tee Shirt (navy blue, white print)

Detail shirt front

Keith Baker, KB1SF / VA3KSF
kb1sf@amsat.org

AMSAT's presence at the annual Dayton Hamvention® is always a mixture of the new and surprising as well as a chance to meet old friends and make new ones. And this year's Hamvention® was no exception.

They say that for a ham radio operator, attending the Dayton Hamvention® is a lot like climbing Mt. Fuji in Japan for someone of Japanese heritage…. you must do it at least once in your lifetime. It is also said (with tongue firmly planted in cheek) that if you stand in the middle of the Dayton Hamvention® flea market and throw a hot dog in the air, it will be cooked when it lands from all the RF floating around!

Clearly, there is nothing else quite like Dayton in the fascinating world of amateur radio.

As in past years, AMSAT's presence at Dayton started with a visit to AMSAT's storage locker on the Thursday before the event to upload various booth items to a rental van. Then came the absolutely massive logistical challenge of unloading, re-assembling and setting up AMSAT's various booths at the HARA Arena complex. As in past years, AMSAT occupied a number of booth spaces in the Ball Arena area of the HARA complex. Our booths were located adjacent to the extensive ARRL Expo area and just a quick walk from our outdoor AMSAT satellite demonstration area that the Hamvention® organizers graciously set up for us every year in the adjacent parking lot.

Our crew, many of whom later spent a good portion of their Dayton 2013 experience manning AMSAT's booth, included Don (VE3VRW), Barry (WD4ASW), Kate (KB1OGF), Keith, (KB1SF), Frank (KA3HDO), Jonathan (KF5IDY), Jerry (N0JY), Joe (N7QPP), Steve, (K8UD), Dave (WB9BRX), Burns (W2BFJ), Jim (W2IMY), Mark (N8MH), Alex (N3NP), Patrick (N8PK), Taylor (K4OTZ), John (K4SQC), Ed (K9EK), Jim (W3IPO), Zachary (KJ4QLP), Roger (WA9PZL), James (W5AOO), Nancy (KC8GYW), EMike (KC8YLD), Tony (AA2TX), Doug (KD8CAO), John (K8YSE), Chuck (K3PER), Keith (W5IU), Douglas (KA2UPW), Jay (WB8SBI), John (N4QQ), Todd (KC8HUA), Joe (K6WAO), Dave (W8AAS), Stefan (VE4NSA), Bill (K4BLL) and Mike (WB8CXO). All served under the expert leadership of our "Booth Czars" Steve (N9IP) and Alan (WA4SCA), and of course, our hard-working AMSAT Office Manager, Martha.

Once again at this year's Dayton Hamvention® AMSAT booth had an abundance of new (and older) hardware and software on display as well as some new printed material and fashions to add to AMSAT's continuing line of wardrobe items.

New fashion accessories included new AMSAT Golf and T-shirts as well as hats and stickers. A wideband VHF/UHF receiver preamp – designed and built by Mark Spencer, WA8SME. Described by Mark, ARRL's Education and Technology Program Director for the Teacher's Institute in a recent QST article, this low-cost preamp is great for portable satellite operations with a handheld antenna.

Also new this year was the recently compiled DVD of the "Proceedings of the 30th AMSAT-NA Symposium and Annual Meeting" along with all symposium papers, 1986 to present and a Fox-1 Satellite Cardboard Model Kit – designed by Stefan Wagener, VE4NSA. The latter is a 1:1 scale cardboard model of the Fox-1 CubeSat. The model is printed in color on heavy stock paper, including all components. The instructions are carefully prepared to allow for easy assembly requiring scissors, glue etc. Depending on experience, assembly takes approximately 10+ hours.

Besides these new items, updated items from past years included a revised and updated "2013 Getting Started with Amateur Satellites" book, and an updated (and laminated) "2013 Amateur Satellite Frequency Guide" which was also used as a premium for new and renewing BASIC memberships completed at the booth. Assembled and tested LVB Trackers with new OLED displays in enclosures and FTDI serial to USB modules were also offered along with Elk hand-held satellite antennas and carry bags.

Software offerings included the very latest editions of SATPC32 and MacDoppler PRO tracking software. We also had Elk antennas and LVB Trackers with the latest firmware on hand to offer Hamvention® attendees.

The AMSAT engineering area this year once again included a structural engineering prototype of the FOX-1A satellite along with a working model of the satellite's internal housekeeping unit (the IHU … the "brains" of the satellite). This circuit board was also transmitting greetings from FOX-1A to passersby who tuned their HTs to 145.920 MHz. Additional FOX prototype circuit boards were also on display in the engineering booth.

Other "hands-on" satellite opportunities at Hamvention included multiple satellite demonstrations that took place right outside of the Ballarena entrance. Led by Keith Pugh, W5IU and Roger Ley, WA9PZL and supported by a host of other volunteers, a number of contacts were made on various LEO satellites during the weekend. The demo provided an opportunity for people attending the demonstration to make contacts themselves and to gain a better understanding of what constitutes an amateur satellite ground station.

Over the years, AMSAT has sponsored a variety of social events in Dayton. In the last few years, AMSAT members and friends have gathered at the Tickets Pub and Eatery in Fairborn on Thursday evening after the AMSAT booth is assembled around 6:30 PM. The Ticket's management graciously provides us a separate area in the pub where everyone has a chance to relax and refresh after the day's efforts.

Then, once again on Friday night, over 100 members and guests attended the joint TAPR/AMSAT dinner held at the Kohler Presidential Banquet Center in Kettering. TAPR President Steve Bible, N7HPR, was this year's moderator. We began the evening with cocktails and conversation, followed by an excellent buffet dinner. Afterwards the featured speaker, Bruce Perens, K6BP , gave a presentation entitled "The Evangelist's Dilemma: Driving New Ideas With Nothing But Words". In his talk, Bruce presented a humorous history of technology evangelism and the things that inevitably go wrong along the way, drawing from his personal experiences in introducing (and sometimes implementing) such forward-thinking concepts as Open Source software, No-Code, Software Freedom, Codec2, and Open Hardware.

The AMSAT Forum this year included six speakers, covering the usual topics about AMSAT operations and plans, but also new developments for future spacecraft. The 2 hrs and 15 minutes allotted to the forum is one of the Hamvention's longest. AMSAT Secretary Alan Biddle, WA4SCA served as the forum moderator and, as in past years, the venue was filled to overflowing with several people standing around the side of the room.

Presenters and their topics included:

Barry Baines, WD4ASW: "AMSAT Status Report." AMSAT President Barry Baines highlighted current activities within AMSAT and discussed some of the challenges facing the organization.

Frank Bauer, KA3HDO, "ARISS Program Status." As AMSAT's Vice President for Human Spaceflight, Frank discussed the latest status of the ARISS program including the shifting interfaces among NASA, AMSAT and the ARRL. He also showed photos of the HAM TV system that is slated to be deployed on the International Space Station.

Tony Monteiro, AA2TX: "FOX-1 Status Update." Tony, AMSAT's VP of Engineering, discussed the design and current status of AMSAT's newest project and AMSAT's plans for follow-on CubeSats.

Howard Long, G4LVB: "The FUNcube Satellite" Speaking as an AMSAT-UK Committee Member, Howard discussed the AMSAT-UK's "FUNcube" satellite project including their plans for educational outreach and further Amateur Radio CubeSat development in the United Kingdom.

Mark Hammond, N8MH: "Amateur Satellites, Education, and YOU!" Mark, AMSAT's VP of Educational Relations, also spoke about the educational partnership among AMSAT, the ARRL, NASA and various universities. He noted

that "education" was quickly becoming critical for future rides to space for AMSAT's satellites.

Mark Spencer, WA8SME, "FOX Classroom Experiments" Mark, ARRL's Director of Education and Technology, discussed the joint efforts between the ARRL and AMSAT to develop educational STEM (Science, Technology, Engineering and Math) activities. Initially, these efforts will use AMSAT's FOX-1 CubeSat to bring amateur radio in space science experiments within the reach of students in the classroom.

Video from a number of the 2013 AMSAT forums (and other activities at Dayton) have now been captured and uploaded onto YouTube (www.youtube.com). Just enter **http://www.youtube.com/AMSATNA** into your Web browser and then click on those videos that may be of interest to you.

Needless to say, this was another highly successful Hamvention for AMSAT, aided by relatively good weather for two of the three days and a solid Hamvention turnout. Official attendance at this year's show was just under 25,000, about the same as it has been in previous years. Clearly, the Dayton Hamvention® remains "the place to be" for the movers and shakers in amateur radio.

Of course, for AMSAT as well as any exhibitor, Hamvention was not over until long after the attendees were well on their way home with their new "toys". Finishing up the show included packing and shipping satellite components and materials, as well as breaking down the booth and returning its various components to our local storage facility to await Hamvention 2014.

And, once again, AMSAT will be there.

Make your plans now to join us!

AMSAT President Barry Baines, WD4ASW gave the AMSAT Status Report.

The AMSAT Booth at Dayton 2013.

The AMSAT tracking software and the LVB Tracker box at Dayton 2013.

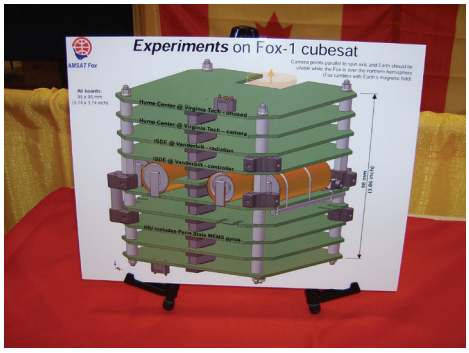
Keith, W5IU operating a pass in the satellite demonstration area.

Keith, W5IU (front) and Roger, WA9PZL (rear, left) and a host of volunteers staffed the satellite demo area.

Alan, WA4SCA answers questions at the AMSAT Booth at Dayton 2013

The AMSAT Banquet at Dayton 2013

Fox-1 cubesat engineering model on display at the AMSAT booth.



Details of the Fox-1 cubesat module layout on display at the AMSAT booth.

Gaston Bertels – ON4WF
ARISS-Europe chairman

A new era is opening for amateur radio on the International Space Station The ARISS Ham Video transmitter was delivered by Japanese cargo spacecraft HTV-4, which launched August 4 and docked 5 days later. The Ham Video gear is presently aboard the Columbus module of the International Space Station.

ESA astronaut Luca Parmitano, IR0ISS reported that the bags are stored in Columbus. There are two bags: one for the transmitter, the other for the power, camera and antenna cables.

When the Ham Video transmitter becomes operational, it will be used for ARISS educational school contacts. Video will be for downlink only. Uplink will be VHF FM audio. The Ericsson transceiver onboard Columbus will be used for reception onboard. This cross-band and dual-mode operation is called Ham TV. Ham Video is the name of the Digital Amateur Television (DATV) transmitter. Figure 3 shows a photo of the HamTV transmitter front panel.

Installation will be done by US astronaut Michael Hopkins, KF5LJG, who has been trained for the commissioning of the Ham Video equipment. The commissioning is planned later in the year, possibly at the end October, 2013, when there are favourable passes over Italy. The test transmissions during commissioning of the onboard equipment will be received by the ground station of the "Centro di Geodesia Spaziale" of the Italian Space Agency, located in Matera, Southern Italy.

Ham Video Commissioning Testing Successful

The commissioning testing kick-off meeting took place November, 2012 at ESTEC, the European Space Research and Technology Centre, located in Noordwijk the Netherlands. Detailed procedures were examined and finalized during weekly European Space Agency (ESA) and ARISS teleconferences. A preliminary Experiment Sequence Test involving the ARISS ground station IK1SLD, located in Casale Monferrato in Northern Italy was planned to occur the last week of August.

Ham Video Experiment Sequence Test (EST) was performed August 28-29 and simulation testing was done September 5-6, 2013.

IK1SLD, which is an ARISS telebridge station often used for educational ARISS school contacts on VHF, has been upgraded for S-band reception. Ham Video manufacturer Kayser Italia delivered a 1.2 meter dish, a down converter and precision tracking motors, which are part of the ESA funded equipment. For the EST, the station will receive a DATV signal from a local low power S-band test transmitter. The decoded signal will be 'webstreamed' to the British Amateur Television Club (BATC) server. ESA examiners will connect to the BATC server and evaluate reception. The test transmissions at IK1SLD will cover the different frequencies and symbol rates available on the Ham Video transmitter.

For on-orbit commissioning testing, the VLBI (Very Long Baseline Interferometry) station of the Italian Space Agency (ASI), located near Matera, southern Italy, will be used for receiving the DATV signals from the ISS.

During the EST, a low-power transmitter, installed in the shack, generated signals on the Ham Video frequencies, transmitting a DATV recording at 1.3 and 2.0 MS/s and forward error correction ½. The DATV signal was received and decoded by the IK1SLD station and webstreamed to the BATC server. These are available on the "Members Streams" of the BATV's website:

http://batc.tv/ch_live.php?ch=5

The Belgian User Support and Operations Center – ESA (B.USOC) conducted operations. Specialists from the B.USOC and the European Astronaut Center – Cologne, Germany (EAC) operated from Livorno at Kayser Italia's laboratory using the 'Elegant BreadBox' version of Ham Video. Parties involved were connected with one another via teleconference. At Casale Monferrato, Claudio Ariotti IK1SLD and Piero Tognolatti I0KPT produced, received and webstreamed the signals in the different configurations as requested by B.USOC. ESA and ARISS observers participated to the EST teleconference. After debriefing, the EST was declared successful.

Simulations were conducted differently. B.USOC supervised from their offices in Brussels with ARISS participation by Piero Tognolatti I0KPT and Jean Pierre Courjaud F6DZP operating from home. The simulations were done in the Columbus mockup at EAC, where a non-operational Ham Video model is installed. This box is used for astronaut training on Ham Video. A KuPS power supply was also used, as well as a camera similar to the one onboard Columbus in space. Ham Video transmissions were simulated in the different configurations (frequencies and symbol rates). A view of operations in the Columbus mockup was webstreamed to the participants. ARISS operators simulated reception as if they were at the Matera ground station, taking into account expected timing between AOS and LOS. The operators signaled AOS and requested "crew" at EAC to transmit in different configurations, following a pre-determined scenario. At LOS, the test stopped and results were analyzed.

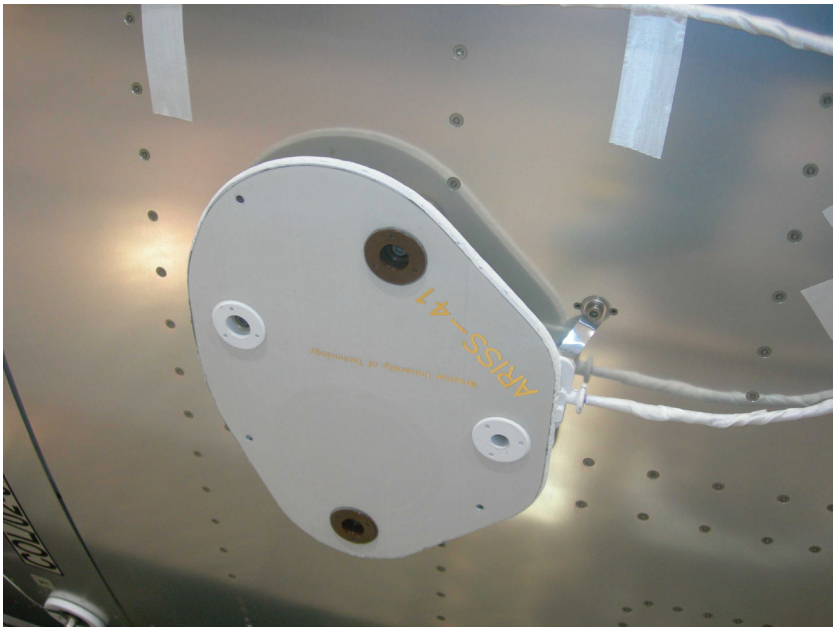


Figure 1: One of the Columbus Module L/S dual-band Antennas

Four "passes" were simulated this way, using both ARISS antennas. An important goal of the simulations was to check the efficiency of communications between ground and "crew". Commands were initiated by ARISS operators (supposedly from Matera), received at B.USOC, relayed to the Columbus Control Center at Oberpfaffenhofen near Munich and uplinked to "crew" by EUROCOM. The European ISS Control Center is called Col-CC and its spacecraft communicator's call sign is EUROCOM. The simulations were conducted successfully and lessons were learned for gaining time on transmitting commands. This is important considering the limited 8 minutes contact time during real commissioning from orbit.

Presently, ISS pass predictions for Matera are computed for several weeks starting mid-October, 2013, The Matera VLBI activities are to be taken into account for determining usable passes. Four passes will be needed to fulfill the commissioning requirements.

The Ham Video commissioning activities will be decided by ESA and NASA ISS Operations. Hopefully the commissioning will be planned during Expedition 37

The Ham Video transmitter may possibly transmit continuously between the commissioning steps, offering amateur ground stations the opportunity to test and tune their receiving equipment. The transmissions will be performed in automatic mode, without requiring crew time. The camera, which runs on a battery, will not be used and the ground stations will receive a black image. Meanwhile, preparation for commissioning the Ham Video equipment is making steady progress.

Web streaming will take advantage of the special software developed by Jean Pierre Courjaud, F6DZP. References are available in the HamVideo.pdf which can be accessed at:

http://www.ariss-eu.org/HamVideo.pdf.

The Columbus project

As far back as the year 2000, a proposal for an ATV system on the International Space Station was submitted to the ARISS Project Selection and Use Committee by Graham Shirville G3VZV.

In November 2002, a request for amateur radio facilities on the Columbus module which was then under construction was submitted by Gaston Bertels, ON4WF to Mr Jörg Feustel-Büechl, Director of Manned Spaceflight and Microgravity Directorate of the ESA.

The request was to install wideband amateur radio antennas on the earth-facing side (nadir) of Columbus. With such antennas, the on board amateur radio facilities could be extended to amateur TV. Figure 1 shows a photo of a L/S dual-band antenna on the exterior of the Columbus module.

In 2003, the request was examined in detail and finally accepted. ARISS would pay for the development, manufacturing and qualification of the antennas. ESA would support the installation cost.

ARISS-Europe started a funding campaign, all donations being published on the website.

In 2004, coaxial feed-throughs were installed on the port cone of Columbus. This was needed for accessing the antennas with feedlines from inside the module.

In 2005, the Royal Belgian Amateur Radio Society (UBA) signed a contract with the Wroclaw University of Technology, Poland for the development and manufacturing of the antennas. Whereas initial plans were for UHF, L-band and S-band antennas, only L- and S-band antennas could be ordered because of lack of funding. The cost of the project was 47,000 Euro.

In early 2006, the antennas were delivered to ESA. Meanwhile main Columbus contractor, EADS, and subcontractor Alenia Spazio had reviewed mechanical and thermal constraints. Wroclaw University proceeded with a set of qualifications tests (cost 3.000 Euro) and the antennas failed.

In 2007, an additional contract was signed with the Wroclaw University for the development of modified antennas. This amounted to 36.000 Euro. These antennas were accepted and installed on Columbus, October 2007.

The cost of the antennas finally amounted to 86,000 Euro and was covered by a worldwide funding campaign.

ESA supported the total installation cost of the antennas, including feed throughs and coaxial cables.

After the successful launch of Columbus and its integration into the International Space Station complex, an ARISS-Europe working group started a study for the development of an amateur television transmitter on Columbus, using one of the S-band antennas. A debate started between the supporters of analog television (ATV) and the proponents of digital television (DATV). The working group, which met via monthly teleconferences, made progress, but was stuck by the lack of funding.

Meanwhile a possibility opened for the installation of VHF/UHF antennas on Columbus. The European Space Agency wanted a VHF antenna for a specific payload and was interested in the manner which ARISS antennas had been attached to handrails on the Russian service module. A similar system was adopted for Columbus and, in the same time, ESA accepted the installation of a dual band VHF/UHF antenna for ARISS. This antenna project was funded entirely by AMSAT-NA and volunteers who built the antennas for both the ESA experiment and for ARISS. The installation was done during an extra-vehicular activity (EVA) on 21 November 2009. Soon an Ericsson UHF transceiver, which had served in the early ARISS days, migrated from the Russian to the American segment of the space station and started packet radio operation.

As time went by, the debate on ATV versus DATV evolved at the advantage of the latter, but no funding was in sight. Then, suddenly, supported by the enthusiasm of Italian astronaut Paolo Nespoli IZ0PA, who had performed many ARISS school contacts during his 2010-2011 expedition aboard the Space Station, AMSAT Italia and Kayser Italia, an Italian manufacturer, presented a project for an amateur radio DATV transmitter to ESA's educational services.

In 2012, this proposal was accepted and ESA signed a contract with Kayser Italia for the development and the manufacturing of a DATV transmitter on S-band. This transmitter, dubbed "Ham Video", is presently onboard Columbus, but not yet installed. Commissioning is slated October 2013.

Ham Video

The Ham Video DATV transmitter, developed for installation in the Columbus module, features the following characteristics:

- Downlink frequencies:
  - 2.422 GHz
  - 2.437 GHz
- DVB-S standard (QPSK modulation)
- Symbol rates: 1.3 Ms/s and 2.0 Ms/s
- Forward Error Correction : ½
- SIF: 352x240 or D1:720x480
- RF radiated power : approximately 10 watts EIRP

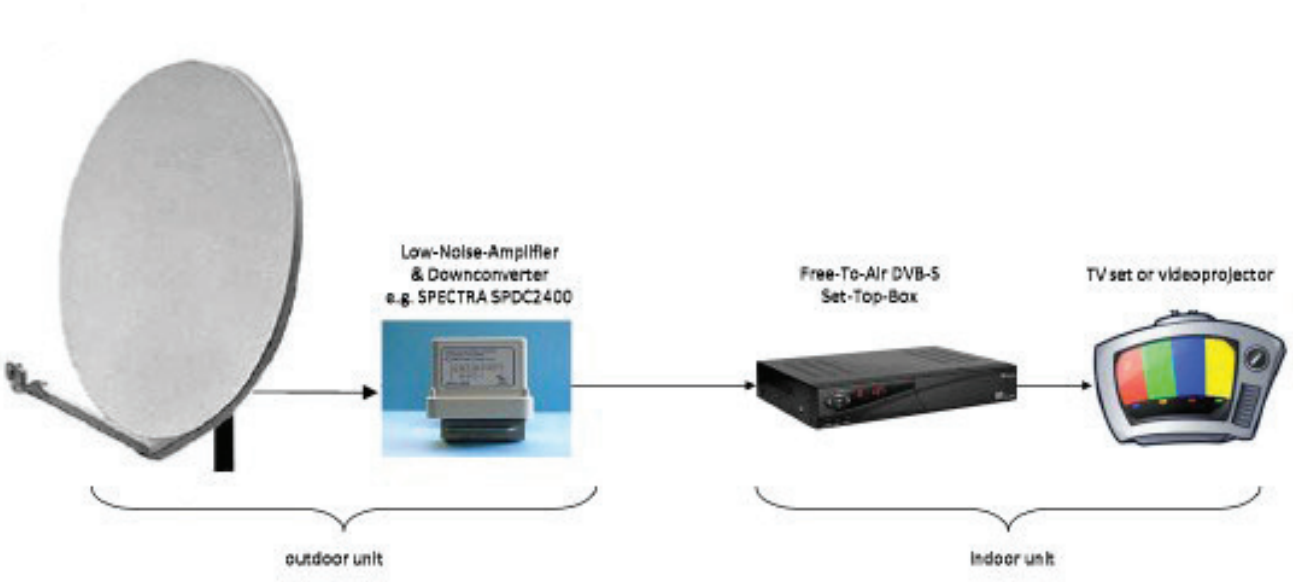


Figure 2: Equipment required to receive HamTV from the ISS

Ham Video will operate with a Canon XF-305 camera, provided by NASA.

Power will be provided by a portable power supply, also known as KuPS, another Kayser Italia product. The KuPS is a standard equipment on Columbus, used for several experiments. It converts the 120VDC, which is the standard main voltage in the American segment, to 28VDC.

Ham Video is downlink only. No DATV receiver is presently considered on board Columbus. From a technical perspective, Ham Video is a standalone payload. ESA will put Ham Video at the disposal of ARISS for educational outreach.

When video-enhanced ARISS school contacts will be conducted, the downlink audio and video signals will be produced by Ham Video and the uplink audio signals will be received with the Ericsson transceiver. In this two way setup, the global system is dubbed Ham TV.

Ham TV

An important element of the Ham TV system is the ground segment. Receiving DATV signals from Columbus will be far more demanding than receiving VHF or UHF. A careful study of the link budget, conducted by Piero Tognolatti I0KPT, shows that DATV decoding should be possible, for a ground station equipped with a 1.2m dish, when the ISS is within a range of about 800 - 1000 km. This limits the time of DATV reception to about 3 – 4 minutes during a favourable pass.

A 1.2 m dish has a beam width of about 4 degrees (between -1 dB points). ISS tracking will be far more demanding than it is for receiving VHF signals.

ARISS will establish a chain of 5 volunteer amateur ground stations, located at carefully chosen places along a typical ISS pass over Europe. These stations will receive and decode the DATV signals and stream the audio and the video over the Internet to the BATC server in UK. The school will connect to the BATC server which offers the possibility to visualise up to 6 images simultaneously. With this setup, Ham Video reception is expected to reach the 15 minute goal ESA has fixed.

ARISS's expectation is, that similar chains of ground stations will be established in other continents, allowing more flexibility for Ham Video enhanced ARISS school contacts.

Ham Video transmissions may not be limited to school contacts. Automated transmission of recorded video can also be envisaged. Several amateur radio experiments can be developed, within the limits proper to the International Space Station.

Ground Station Requirements for Ham Video reception

Main Specifications

- High Gain antenna
  - polarisation : RHCP
  - gain about 26 dB
- AZ-EL rotor
  - accuracy : +/- 2 degrees (1.2 m dish)
  - slew rate : 5° per second
  - range : 0-180 elevation & 0-360 azimuth
- LNB (Low Noise Block downconverter)
  - input frequency : S-band
  - output frequency : L-band
  - gain : at least 40 dB
  - frequency stability : +/- 20 kHz
  - noise figure : about 0.7 dB
- Tracking software capable of flip mode
- DVB-S receiver
- Refer to Figure 2, showing the relationship of the system components.

Ground Station Components

Parabolic antenna with AZ-EL pointing

The dish shall be mounted for azimuth and elevation pointing and moved by precision motors. with a total system pointing accuracy of 2 degrees or less (including motor precision, antenna alignment, and pointing control software). The elevation movement shall cover 180 degrees (flip mode capability). The azimuth movement shall cover 360 degrees or more. A possible alternative to the flip mode for the elevation movement is the capability of azimuth movement up to 540 degrees to allow for reception of ISS passes over north.

Azimuth angular speed greater than 5 degrees/sec allows for reception of ISS passes up to 90 degrees elevation. Less angular speed will allow reception of passes with lower elevation.

The AZ-EL motors for the main European ground stations are made by Prosistel:

http://www.prosistel.it

The driver is WISP DDE by CX6DD:

http://www.mederoscnc.com/CX6DD/wispdde/wispdde.htm

This was modified by AMSAT Italia in order to interface Prosistel rotors in the Azimuth extended-range mode. This modified version of WISP DDE also allows automatic sweeping of the antenna around the sun direction, in order both to check correct AZ/El alignment and to measure the system noise temperature of the receiving system (G/T).

Tracking software

A number of shareware, freeware, cardware and commercial tracking softwares are available on the web. Selection of the software needs to have the capability to drive the AZ-EL motors, flip mode included. The tracking software used for the on-going tests is Orbitron:

http://www.stoff.pl/

LHCP dish feed

ARISS antennas on Columbus are right-hand circularly polarised. Hence, for single reflector antennas, the feed shall be left-hand circularly polarised, since each dish reflection reverses the polarisation. The dish feed can be a patch type or a helix type, positioned in the focus of the parabola. The dish feed used for ARISS-Europe ground stations is a product of RF HamDesign:

http://www.rfhamdesign.com

Low Noise Block Downconverter

ARISS-Europe ground stations are equipped with a low noise block (LNB) downconverter produced by Kuhne Electronic. The LNB is designed for mast mounting near the parabola. Two options are suitable :

Option 1 :

- KU LNC 25 TM (centered 2450 MHz)
- Frequency range : 2350 – 2550 MHz
- IF : 1433.5 – 1633.5 MHz
- Amplification : 40 dB
- Refer to:

http://www.kuhne-electronic.de/en/products/down-converters/ku-lnc-25-tm.html

Option 2 :

- KU LNC 23 TM (centered 2385 MHz - specific DATV.
- Frequency range 2320-2450 MHz
- IF: 1404 - 1534 MHz
- Amplification: 40 dB
- Refer to:

http://www.kuhne-electronic.de/en/products/down-converters/mku-lnc-23-tm.html

The KU LNC 23 TM has a notch filter on 1.3 GHz for duplex operation: 1.3 GHz (transmit) and 2.3 GHz (receive). This could be useful from the perspective of a planned cross band voice transponder on Columbus.

DVB-S satellite receiver

A suitable DVB-S satellite receiver PCI tuner card is produced by Techno Trend:

http://www.technotrend.eu/2920/TT-budget__S2-1600.html

The Techno Trend card fits in a PCI computer slot and supports HD TV (MPEG2 and MPEG4/ H.264) :

- Computer OS : Windows XP, Vista, Windows 7, Windows 8
- CPU for SDTV: at least 800 MHz
- CPU for HDTV: at least P4 3,4 GHz or comparable AMD Athlon (dual-core recommended) - not needed for Ham TV
- 512MB main storage (1024MB recommended) at least 1GB free hard disc storage
- Graphics card with at least 64MB and DirectX 9 support
- Sound card with DirectX 9 support

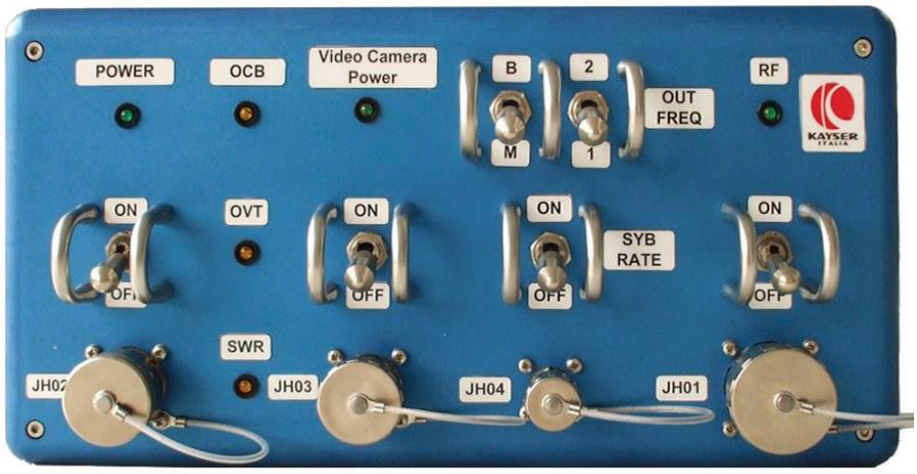


Figure 3: Ham TV Transmitter front panel aboard the Columbus Module

Besides the TT-budget S2-1600 card, TechnoTrend produces the TT-S2-3200 card which is also suitable.

In addition to the PCI card ground station solution described, it is understood that some specific DVB-S "set top" boxes are able to operate correctly at the symbol rates that will be used by the Ham TV system.

Measurement and Display software

Jean Pierre Courjaud F6DZP has developed a free software utility providing radio amateurs and DVB technicians a tool that allows Digital ATV (DVB-S) to be measured precisely. Please see :

http://www.vivadatv.org/page.php?p=tutioune-en

This software comes in two versions :

- Tutioune V2.0 for use with the TT S2-3200 card:
  http://www.vivadatv.org/viewtopic.php?f=60&t=205
- Tutioune 1600 V0.1 for use with the TT S2-1600 card:
  http://www.vivadatv.org/viewtopic.php?f=60&t=214

With the above mentioned setup, Ham Video from Columbus can be received, decoded and displayed on a computer screen. Audio is also available.

Noise Power Measurement for Antenna Alignment

As suggested by Piero Tognolatti I0KPT and with his collaborator, Jean Pierre F6DZP developed a special software for noise power measurement. With this software, a TT-S2-3200 or a TT-S2-1600 PCI card can be used for Dish alignment by measuring the sun noise on S-band:

http://www.vivadatv.org/viewtopic.php?f=67&t=212

Streaming video on the Internet

For H264 encoding and streaming video on the Internet, several software solutions exist:

- Adobe Flash Media Live Encoder (FMLE) – free – Win XP, Win7, Win8
- FFsplit – free – Win7, Win8
- Open Broadcaster (OBS) – free – Win7n Win8
- Xsplit – only basic functions are free – Win XP, Win7, Win8

Under Windows XP, the best solution is FMLE.

For H264 encoding and streaming, a good Dual Core or a Quad Core CPU is needed. Sending the video stream, produced by the DVB-S receiving software, to the Internet encoder/streamer software (FMLE, OBS…) needs additional software such as Vcam. The general ground station setup is shown in Figure 4 :

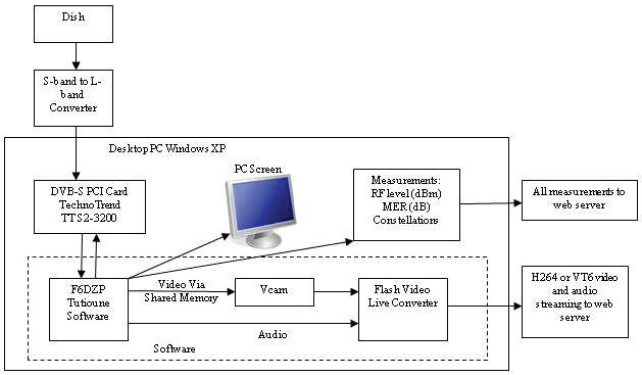
- Solution 1 : based on a DVB-S PCI card
- Solution 2 : based on Set Top Box with Ethernet output

A call for experimenters to set up their own ground stations to receive the ARISS DATV Ham Video downlink is detailed at:

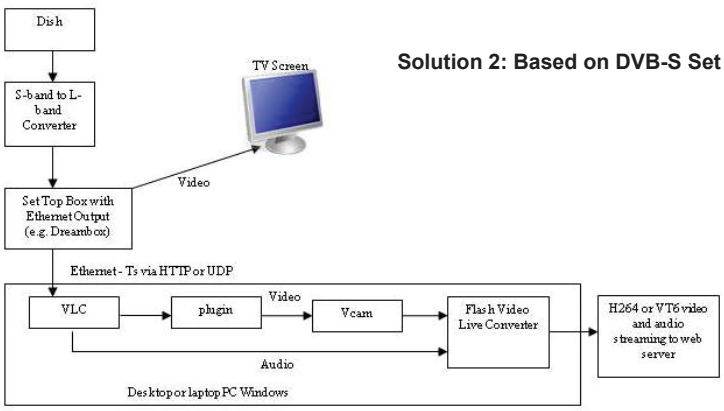
http://amsat-uk.org/2013/09/21/ham-video-launch-campaign/

Figure 4

Solution 1: Based on DVB-S PCI Card



Solution 2: Based on DVB-S Set Top Box



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Solution 2 based on a Set Top Box with Ethernet output

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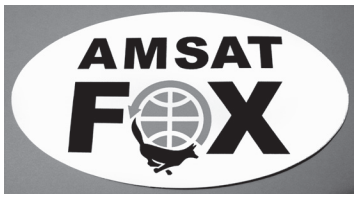

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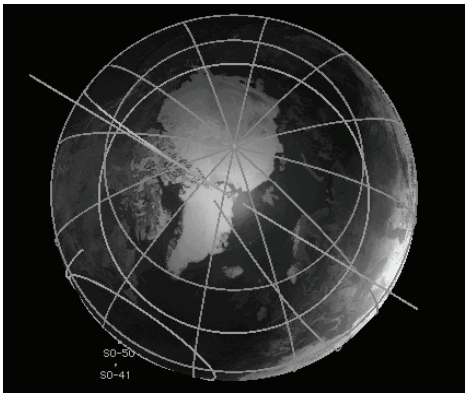
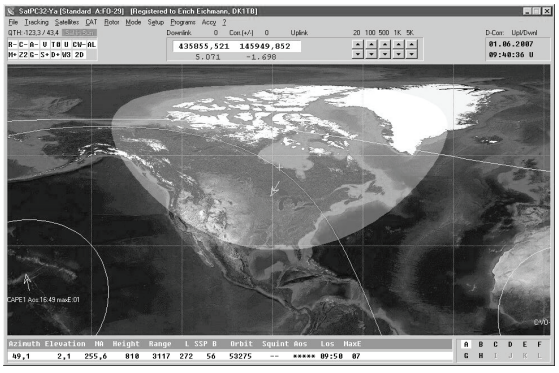


SATPC32 for Windows



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